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PLUCKING EXPERIMENTS AT BORBHETTA.

BY

H. R. Cooper.

Special interest attaches to results of a plucking experiment in the first year of the experiment. It is of great importance to have an idea of the probable immediate effect of any change from the normal plucking system. In the case of these experiments, therefore, a new method of conducting field experiments on tea was adopted, which it was hoped might prove more accurate than the usual method of averaging yields from a number of plots under the same treatment, but selected by chance, irrespective of previous yield.

These particular experiments were conducted on an area of Bazalony tea planted in 1919 at 5 feet by 5 feet triangular. The area consists of eight plots each containing eight lines of eighty bushes. Two lines of tea are missed between each plot, and in the intervals thus left are drains. The outside lines of each plot are therefore about seven feet from the edges of the drains, which are too far to cause the suffering of the bushes which is so noticeable on bushes close to drain-sides, at least in sandy soil. On the contrary the outside lines of tea gain so much from the wide strip of clean soil between them and the drains that they yield about 50 per cent. more crop than the average inside lines. The yields from inside lines vary unevenly.

Each of the 64 lines was plucked in the same manner, and the leaf weighed separately, during the seasons 1924, 1925 and 1926.

At the end of 1926 the lines were divided into 16 sets of 4 lines each, such that each set contained—

1 highly yielding outside line,
1 highly yielding inside line,

1 moderately yielding inside line,
1 poorly yielding inside line.

The lines forming each set were selected so that the sum of the yields from the four lines in each set was within 2 per cent. of the average yield of the 16 sets of four lines.

The four lines of each set, also, were scattered pretty evenly over the block of tea so that small seasonal variation in crop due to such factors as distance of land above water level should not affect any one set unduly.

The sixteen sets of four lines thus represent areas of the same variety of tea of the same age, which have been under similar treatment for seven years, have yielded very similarly for three years, and are similar in situation.

We have therefore reason to expect that if treatment had continued to be similar the yield would have remained very similar, and that differences found under different treatments are directly due to the effects of those treatments.

To measure the accuracy of this assumption two of the most important systems of plucking were each repeated on four separate sets. The yields obtained from these sets were in satisfactorily close agreement.

Plucking system.	Set No.	Yields in lbs. green leaf per 320 bushes 1927.	Average yield.
6" new wood and then to janum	2	761	747
	11	734	
	12	745	
	13	748	
6" new wood, then 1 big leaf, then janum	6	667	671
	14	570	
	15	681	
	16	667	

It will be observed that the maximum differences between the average yield and that of any one set under the same treat-

ment occur in the cases of sets 2 and 11 which differ from the mean yield by 14 lbs. or about 2 per cent. In the cases of the 6 other sets agreement is very close indeed. It may be assumed therefore that the experimental error of the result from any one set is not likely to exceed 2 per cent.

The tea was heavily centred early in 1921, cut at 20 inches and spaced out a year later, and top pruned since. Top pruning in 1926 and 1927 was absolutely flat, leaving a horizontal surface, one inch above the previous year's pruning : dead wood and banjhi shoots were removed but poor shoots if they showed more than two plucking marks were left.

In these experiments we are dealing with generally vigorous, mature, high tea. The results would not apply to the cases of low, or poor tea; and would not necessarily apply even to this same tea if it were differently pruned, or manured, or subjected to different weather factors.

In all these experiments two leaves and a bud only were taken; if any shoot showed three leaves above the position indicated by the system of plucking, the third leaf was broken back and thrown away. From any shoot which was *banjhi* the top leaf only, while still soft, was taken into the baskets; any second or third leaf from a *banjhi* shoot being broken back and thrown away ; these orders were, of course, not perfectly carried out, but accidental departures from them were infrequent. Plucking in every case was on Friday in each week.

In the tables are shown the total leaf plucked in each period of four weeks (sum of four pluckings). The results obtained are discussed below.

TABLE I.

Trial No.	PLUCKING SYSTEM.	LBS. LEAF PER 320 BUSHES (TO NEAREST LB.)									Mds. pucca tea per acre.
		April 8th to April 29th	May 6th to May 27th	June 3rd to June 24th	July 1st to July 22nd	July 29th to Aug. 19th	Aug. 28th to Sept. 18th	Sept. 25th to Oct. 14th	Oct. 21st to Nov. 11th	Nov. 18th end of season.	Total for year.	
1	4″ new wood, then to janum	30	3	97	89	110	134	158	101	34	755	14·79
2	6″ „ „ „	21	3	99	85	106	144	159	97	30	747	14·63
3	8″ „ „ „	14	3	97	82	100	140	159	101	36	733	14·37
4	10″ „ „ „	8	3	69	61	100	135	151	104	31	660	12·93
5	4″ new wood, then 1 big leaf, then janum	27	4	89	60	106	133	143	100	32	693	13·59
6	6″ „ „ „	20	3	87	51	110	124	144	104	30	671	13·15
7	8″ „ „ „	14	3	83	57	110	125	148	102	30	672	13·17

(1) *Effect of Leaving Different Lengths of New Wood before Plucking.*

It will be seen from trials No. 1 to 4 (Table I) that during April when the first flush only was being taken, the closer the plucking the greater was the yield obtained. During May no system of plucking yielded any significant quantity of leaf, because growth of all bushes was then so stunted as to be practically stopped by what is generally described as "green-fly" attack. Only a few very small shoots were taken until the bushes "came through" in June. In June yields were almost identical whether $\bar{4}$, 6, 8 inches of initial growth had been left, but many shoots were going *banjhi* at about 8 inches, and did not reach the 10-inch level, so that crop from leaving 10 inches of new wood was reduced significantly. For the rest of the season there was very little difference in crop whether 4 inches, 6 inches or 8 inches had been left originally; but when 10 inches were left a further loss occurred in July when waiting for shoots to grow 2 leaves and a bud above 10 inches before plucking. After that crops were much the same from all four systems of plucking for the remainder of the season.

It would appear then from these trials that it makes little difference to crop whatever initial growth is given up to 8 inches, except very early in the season when collecting "tippings" of small value for tea making.

This result is confirmed in trials No. 5 to 7 when a big leaf is left after the first flush. Here again there is no very great difference in crop whether 4 inches, 6 inches or 8 inches initial growth is left.

It is very necessary to consider whether this result is of general application. It is generally expected among planters that sparing plucking early in the season will give more tea at the end of the season. The early close to the season in 1927 might have reduced the late crop from the more sparingly plucked bushes in these trials. The "green-fly" attack in May,

on the other hand, might have reduced the expected early crop from the more closely plucked bushes.

It is probable, however, that the total yields quoted are normal for the type of big, vigorous, leafy, well-manured bush used in these trials. On such bushes it probably does make only a small difference to final crop whether 4, 6 or 8 inches of initial growth is allowed. When ten inches were left there was a considerable difference because so many shoots went *banjhi* before reaching 10 inches, and took a long time to come through again and grow above the 10 inches level. From general observation it appears that shoots from different bushes go *banjhi* after different lengths of growth. Very poor bushes scattered among the tea of this experiment went *banjhi* long before they reached 8 inches. On another area at Borbhetta the check plots from a series of manuring plots gave 5.8 maunds tea per acre when plucked to 8 inches in 1927 whereas in the very similar season 1925 they had given 7.7 maunds when plucked to 6 inches. In 1927 the second flush was not being taken from these plots to any significant extent till the end of July.

When a shoot is going *banjhi*, the act of plucking (which is in effect a light pruning) stimulates fresh vegetative growth, and thus forces a fresh flush. This forcing must further debilitate a weak bush; while if the *banjhi* shoot is left to grow till new growth comes away, the effect must be to strengthen the bush considerably. Experiments at Tocklai over a series of years show most remarkable improvement in the appearance of bushes from which *banjhis* are never plucked. The present evidence therefore indicates that if a section of top pruned tea is plucked at 8 inches, there will be little loss of crop from the good bushes, while the poor ones will be improved very considerably. Good bushes may stand plucking to 6 inches, but little increase of crop is to be expected from the harder plucking of such good bushes. If poor bushes are plucked to 6 inches the probability is that they will lose vigour still more; while if poor bushes were plucked to 8 inches a loss in crop is to be

expected, but a gain in vigour sufficient to justify the loss of crop may be looked for.

(2) *Effect of Leaving a Big Leaf after Tipping.*

It has been pointed out above that crops, after May, varied little whether 4 inches, 6 inches, 8 inches initial growth were left: but, it will be seen from Table I that the leaving of a big leaf over the initial plucking causes a very considerable loss of crop.

In the cases of the trials leaving 6 inches initial growth, the experiment was repeated on four series of four lines each, both when plucking was afterwards immediately to the janum, and when a big leaf was left. The individual results from each set are quoted in order to give an idea of the probable accuracy of the averages (Table II).

Table II.

Effect of leaving of big leaf after 6 inches initial growth on crop during season.

	6" to janum.		6" then 1 big leaf then janum.		Loss from leaving leaf.
	lbs. ozs.	Mean.	lbs. ozs.	Mean.	lbs. ozs.
June 3rd to June 24th ..	102 7½ 100 2 98 6 94 0	98-12	92 4 84 6½ 81 14 80 0	87-4	11 8
July 1st to July 22nd ...	90 7 84 7 81 14 83 8	85-1	50 1 49 2 53 15 51 4	51-2	33 15
July 29th to August 19th ...	101 14 110 3 109 0 102 6	105-14	116 11 109 6 108 12 103 13	109-10	3 12 (gain)
August 26th to September 16th	147 11 139 7 144 10 142 11	143-10	119 4 126 12 125 3 126 11	124-8	19 2

	6″ to janum.		6″ then 1 big leaf then janum.		Loss from leaving leaf.
	lbs. ozs.	Mean.	lbs. ozs.	Mean.	lbs. ozs.
September 23rd to October 14th	166 2 154 7 159 10 154 8	158-11	145 7 143 6 142 2 145 9	144-2	14 9
October 21st to November 11th	96 9 101 2 93 12 95 0	96-10	98 11 105 14 103 9 107 7	103-14	7 4 (gain)
November 18th to end of season	21 13 31 9 34 11 31 14	30-0	34 13 29 1 28 15 27 14	30-3	0 3 (gain)
Total for year 1927	760 10 748 1 745 4 732 4½	746-9	680 12 669 9 667 4 666 12	671-1	75 8 (or 10% loss for season)

The second flush was coming away early in June and carried on into July. During these two months it will be seen from Table II that there was a very marked loss of crop when a big leaf was left, while waiting for the extra leaf to grow and later probably because the more leafy bush received less stimulus to growth.

During the next four-week period (August), a slightly increased crop was obtained when plucking over the big leaf. This, however, was not maintained and the more leafy bushes flushed less strongly from the end of August till the middle of October. For the remainder of the season the bushes plucked over a big leaf gave slightly bigger crops than the hard plucked bushes. It is, of course, possible that if the "back end" of the season had not proved so much poorer than in average seasons, the more lightly plucked bushes might have made up more of the loss they had made earlier in the season.

In 1927 the loss from leaving a leaf over 6 inches initial growth, amounted to 10 per cent. of the crop, which on this tea is equivalent to a maund and a half of tea per acre. When

plucking to either 4 inches or 8 inches initial growth, the losses from leaving a big leaf were similar as will be seen from Table I.

When examining the bushes at the end of the season, it was not considered by any observer that there was generally any noticeable improvement in the appearance of the bushes from more sparing plucking applied by leaving a leaf. In following years, improvement may become noticeable.

When the bush is spared by leaving longer initial growth as long as 10 inches the improved appearance of the bush, and the greater thickness of the pruning wood was quite marked, even to casual observation, although the crop obtained (12.93 maunds) was little less than was obtained from leaving a big leaf over an initial growth of 6 inches (13.15 maunds).

On the whole, as far as one can guess from the limited evidence available, it is considered that if bushes require more sparing plucking (as a measure of renovation) it would be better to leave longer initial growth than to leave growth afterwards. If one plucks to 8 inches the poor bushes will go *banjhi* before they reach 8 inches and by the time they come away again, will be more spared than if growth be forced by plucking at 6 inches even though a leaf were left later.

The leaving of 8 inches on average tea (about 7½ maunds per acre) would reduce yields greatly for a time. The average section in commercial practice is a mixture of good high bushes, and poor low bushes. The former generally get away and tend rather to be underplucked, the latter are generally badly over-plucked and get worse and worse. The very even sheets of tea at Tocklai and Borbhetta, and on many gardens, have been produced by plucking to a measure from the ground for some years at least. This method ensures that the weak bushes are not plucked hard, until they can stand it.

Growth by end of Season after Tipping at Different Heights.

At the end of the season, twelve bushes in each line were measured to determine the total length of growth made during

the season above the pruning level, both in the centre and on the extreme outside. Six of these bushes were from the north end where the soil is good, and bushes consequently vigorous: the other six were from the south end, falling on a strip of poor soil carrying poor bushes.

The following results were obtained:—

TABLE III

Growth above pruning level during season.

(Each figure is the mean of 24 bushes; except those from 6 inches plucking which are means of 96 bushes).

Style of plucking.	Good bushes.		Poor bushes.	
	Central shoots.	Outside shoots.	Central shoots.	Outside shoots.
	ins.	ins.	ins.	ins.
4″ to janum	9·9	8·4	8·4	7·2
6″ ,, ...	10·9	9·6	10·0	8·0
8″ ,, ...	11·9	10·4	10·2	9·0
10″ ,, ...	13·9	12·6	13·6	11·6
4″ then 1 big leaf then janum ...	12·2	11·2	10·1	9·1
6″ ,, ,, ,, ...	13·1	11·6	11·4	10·0
8″ ,, ,, ,, ...	13·7	11·6	12·3	10·7

It will be observed that a difference of 2 inches in original plucking height makes a difference of only about 1 inch by the end of the season, except in the case of the 10 inches plucking which by the end of the season leaves the bushes about 2 inches higher than the 8 inches plucking.

It will be observed also that the good bushes had grown at least an inch higher than the poor bushes, and that the centres of all had always grown higher than the outsides by about an inch. These differences are due to differences in lengths of stalk between the last plucking and the new janum.

It will be seen also that the leaving of a big leaf makes a bush at the end of the season about two inches higher than when plucking to the janum on the same length of wood.

The measurements given can only be accepted as indications. There is a great variation between the heights reached by different bushes under the same system of plucking, the vigorous bushes making greater lengths of growth than the poor ones. The measurement is also a difficult matter.

In the case of the "6 inches-to-janum," and "6 inches-leaving-a-big-leaf" systems of plucking, each of which were repeated on four different sets of four lines, the following figures showing rather poor agreement were obtained.

Growth from bushes tipped at 6 inches.

Style of plucking.	Good bushes.		Poor bushes.	
	Central shoots.	Outside shoots.	Central shoots.	Outside shoots.
	ins.	ins.	ins.	ins.
6 inches to janum	11·0	9·5	9·9	9·0
	10·9	9·6	10·0	8·6
	11·0	9·7	8.9	8·2
	10·5	9·2	9 6	8 5
Average ...	10·9	9·5	9·6	8.6
6 inches, then 1 big leaf, then janum	12·8	11·0	12·0	10·6
	12·4	11·8	10 8	9·4
	13·1	11·3	11·3	10·2
	14·0	12·2	11·4	9·9
Average ...	13·1	11·6	11·4	10·0

(3) *Trial of Leaving Leaf while Maintaining Flat Bush.*

When a leaf is left on the second flush the surface of the bush becomes slightly convex; growth is more vigorous in the centre and there is a greater length of stalk between the first plucking mark and the new big leaf above it in the centre than

on the outside. Even near the centre, growth is not quite even so that pluckers when leaving a leaf take shoots from somewhat different levels, and the result is a somewhat uneven, and, in places, too empty plucking surface. The great advantage of plucking to a measure is the ease of accurate plucking once the plucking surface is established. A slight modification of the system of " leaving a leaf " was therefore tried. The initial length of 6 inches having been left and a flat surface established, a new measure of 8 inches from the pruning surface was issued, and plucking thereafter was at the 8-inch level. This had the effect of leaving much longer growth on the outsides so that early crop was lost. The resulting bush at the end of the season had a flatter, and more even, fuller surface, with stronger outsides, so that the loss made may probably be expected to be made up in later years.

The loss in crop was made between June 3rd and July 22nd when 116 lbs. leaf were taken by plucking to 6 inches and then to 8 inches, as against 138 lbs. from leaving a big leaf over 6 inches initial growth. During the remainder of the season crops were about the same.

(4) *Trial of Conical Plucking and Effect of Leaving Young Leaf on Bush.*

A trial of the old " conical " system of plucking was also made.

Supporters of such systems advance three main arguments in their favour:—

(*a*) A conical bush has a larger plucking surface than a *flat bush.*

(*b*) The centre shoots must grow more rapidly than the outsides, which latter are bound to grow weakly and can only yield well if plucked hard.

(*c*) The bush requires that young vigorous leaf shall be kept on it, if it is to remain vigorous.

With regard to (*a*) it is true that from the conical surface some shoots approximating to the horizontal are plucked : but since from the long growth left much fewer shoots arising from buds near the pruning cuts reach the surface, it is probably generally true that the conical surface has actually fewer plucking points than the closer-plucked flat surface.

(*b*) As far as the first few years are concerned the argument is correct; but if sides are left to grow they do eventually become strong. Bushes plucked flat for some years will carry very nearly as strong shoots on the outside as on the inside branches.

(*c*) The need for " young leaf " appears to vary very much with different bushes in different districts. It is a question very difficult to decide without many experiments in different districts and on different classes of tea.

The actual system tried was probably the commonest throughout tea about twenty years ago. Three big leaves are left when tipping, this commonly leaves about 6 inches in the centre and 3 inches or less on the outsides. Above that two big leaves were left leaving the centre about 10 inches or more, and the outsides about 4 inches. Above that one big leaf is left : subsequent plucking (from about the end of August) being to the janum.

In none of the experiments discussed here had it paid (in the first year) to leave any extra growth after the tipping, but it does not follow that this would be true for all districts and all types of bush.

To test this theory while still keeping a flat bush a trial was made of tipping at 4 inches, then when the sides had come up to the centre, raising the plucking a further 2 inches, and later a still further 2 inches. In Table IV the results of this system are compared with those from the conical plucking, and also with certain variations in flat plucking.

TABLE IV.

System of plucking.	LBS. LEAF PER 320 BUSHES.									Equal to mds. pucca tea per acre.
	Apl. 8 to Apl. 29.	May 6 to May 27.	June 3 to June 24.	July 1 to July 22.	July 29 to Aug. 19.	Aug. 26 to Sept. 16.	Sept. 23 to Oct. 14.	Oct. 21 to Nov. 11.	Nov. 18 to end of season.	Total for year.	
6″, then janum	21	3	99	85	106	144	159	97	30	747	.....
3 leaves, then 2 leaves, one leaf, then janum	41	2	104	45	120	142	118	107	24	703	.....
4″, then 6″, then 8″	28	3	87	65	99	431	168	98	35	726	.....
4″, then 1 leaf, then janum	27	4	89	60	166	133	143	100	32	693	.....
4″, then janum	30	3	97	89	110	134	158	101	34	755	.....
6″, then 8″	19	2	60	56	97	132	154	101	30	650	.....
8″, then janum	14	3	97	82	100	140	159	101	36	733	.....

Table IV gives first the results from plucking to 6 inches, taken as a standard flat plucking for comparison. It will be observed that over the whole season the "conical plucking" shown next in the Table makes about 6 per cent. less crop.

Because the conical plucking attacks the sides so severely the tipping in April yields very considerably more crop than is obtained when the sides are left till they come up to six inches. In June when some first flush was still being taken the conical plucking still yields the more. In July when practically only second flush was being taken there is naturally a considerable loss while waiting for two extra leaves to grow, but the bigger (and coarser) shoots taken above two leaves in the next four weeks give a larger weight of leaf than from the closer plucking. From September 23rd till October 14th, the conical plucking again loses leaf, for during this period many shoots still had to be left till the extra leaf grew. This period was again followed by a period of increased crop which might possibly have been maintained longer had the end of the season proved better climatically; but by this time the outsides were exhausted and *banjhi,* while the centre had grown tall thick shoots, too leafy to receive much stimulus to flushing. The crop after the middle of November was actually smaller than from any other plucking method tried.

At the end of the season the lines plucked by this method present a most ragged appearance. A few very poor bushes had grown no higher in the centre than about 8 inches above the pruning, while the most vigorous had grown 21 inches above the pruning. The average good bush had grown to about 17 inches above the pruning in the centre, sloping down to *banjhi* growth on the sides.

The curved surfaces also were not smooth, but irregular as different shoots grew at different rates. The system was found most difficult to follow accurately, and was very unpopular with the pluckers.

Plucking at 4 Inches, then 6 Inches, then 8 Inches.

These lines were plucked to a 4-inch measure till the end of May, after which 6-inch measures were used. From Table IV it will be observed that yields to the end of June were practically identical with those obtained from plucking at 4 inches and then leaving a big leaf on the second flush. Eight-inch measures were used from July 8th. It will be observed (from Table IV) that up to August 19th, there was little difference whether the bushes were plucked at 8 inches (after plucking at 4 inches and then 6 inches) or at approximately 6 inches (4 inches, then 1 big leaf). For the remainder of the season the bushes plucked 4 inches, 6 inches, 8 inches, yielded better than those on which one big leaf was left over 4 inches. The total gain was only about 4 per cent. and possibly may not be significant: but the result indicates a possibility that there may be conditions under which it pays to leave growth.

The next line in the table repeats (for easy comparison) the results from plucking at 4 inches to the janum. It will be observed that the general principle—that leaf is lost by leaving any growth above the original plucking level—still holds.

Two other results are repeated in Table IV for case of comparison.

In these trials there are three systems of plucking by which the final height of the plucking table above the pruning is 8 inches before the use of a measure is abandoned.

These are—

1. 8 inches to janum yield during season 733 lbs.
2. 6 inches, then 8 inches ,, ,, ,, 650 ,,
3. 4 inches, then 6 inches, then 8 inches ,, ,, ,, 726 ,,

For comparison:

4 inches to janum ,, ,, ,, 755 ,,

Up to the end of May while tipping, the yields vary, as expected, with the closeness of the plucking. (See Table IV.) In June and July both systems (2 and 3 above), under which

later growth is left, lose leaf as compared to the system under which the original plucking height is maintained (8 inches to janum). But system (2) loses much more than system (3) although the bushes have received only one check instead of two. It can only be surmised that the greater stimulus to vegetative growth from the earlier 4 inches plucking was persisting. From July 29th to August 19th all three systems yield alike: but from August 26th to October 14th the 4-6-8 system leads, after which all become roughly equal again.

Once a flat surface at the given height was established the measures were no longer used; but pluckers took all growth above the established level, leaving a small non-serrated (janum) leaf above the last plucking mark. There is always a certain length of stalk between the last plucking mark and the janam left, so that by the end of the season bushes have grown quite considerably above the original level fixed.

After plucking ceased, 12 bushes in each line were measured both in the centre of the bush and on the outside.

Six of the bushes were at the south end, where soil and bushes are particularly good, the other six bushes were at the north end, which falls on a strip of very poor soil.

The following were the results found :—

Length above pruning at end of season.

Plucking system.	South end where soil is good.		North end On strip of poor soil.	
	Centre of bush.	Outsides.	Centre of bush.	Outsides.
	ins.	ins.	ins.	ins.
6″—8″	12·7	11·6	11·9	10·9
4″—6″—8″	10·1	9·1	10·1	8·8
8″	11 9	10·4	10·2	9·0
6″	10·9	9·6	10·0	8·0

In the case of the 4 inches—6 inches—8 inches plucking, the time given between plucking at 6 inches, and plucking at 8 inches was insufficient to allow all shoots to be plucked at 6 inches before the plucking level was raised. Many outside shoots, of course, in all systems of flat plucking may be plucked very little, if at all, during the season, and are thus relatively spared. The system of attacking the stronger shoots first when they have reached only 4 inches, and again when they have reached only 6 inches, while shoots which have not reached the level are untouched, makes the differential character of flat plucking particularly marked, and consequently very level growth over the whole surface of the bush is obtained.

It will be observed that plucking at 4 inches—6 inches—8 inches on the good bushes left less growth at the end of the season than any system except plucking at 4 inches to the janam. It will be observed also that on the good bushes there is less difference between outside and inside than in the case of any other system of plucking; and that there is less difference between the good and the bad bushes than in the case of other plucking systems. When 8 inches was left originally, the good bushes grew distinctly more than after 4 inches—6 inches —8 inches plucking, when 6 inches—8 inches plucking was used the growth obtained was still greater. These differences may be presumed to mean greater distances between successive janams left, or more mistakes in plucking by which occasional big serrated leaves were left instead of janams only. In either case the greater growth would indicate greater vigour in the shoots, and certainly the general appearance of the bushes conveyed that impression.

Definition of "Janam" and of "Big Leaf" as used in these Experiments.

In carrying out experiments on plucking it is, of course, a matter of great practical difficulty to get work done accurately by pluckers. In these experiments the very closest supervision was exercised and it is believed that the number of shoots plucked incorrectly was small.

A greater difficulty arises over definitions. The final length of growth made on those lines which were plucked to the janam, was often commented on by planters. Men from districts where it is customary to leave long growth were inclined to be shocked at the closeness of plucking; while a few men from gardens which practise close plucking thought that the bushes had been rather allowed to run away, and pointed to a certain number of rather large "janams," which might almost be called "leaves."

"Janam" is an Assamese word meaning "birth," and the "janam leaf" means the first leaf on a new shoot arising from the axil of a leaf.

The first leaf on a new shoot is usually so small that it is only a bract at the base of the new stem: it is followed by one (or sometimes more) small non-serrated leaves, which are more oval than the succeeding large, pointed, serrated leaves.

In these experiments when a big leaf was ordered to be left, pluckers were instructed to leave the first serrated leaf. When only a janam was to be left they were instructed to leave the non-serrated leaf nearest to the point of origin of the shoot they were plucking. As the first bract-like janam often falls off by the time the shoot is ready for plucking, or is so shrivelled, or so small as to escape notice, it very often happened that the "janam" left was the second rather large janam, called in Assam the "gol pat" (round leaf). In these experiments, therefore, more growth was allowed than on gardens where the first "eye" only is left, whether the janam leaf below it has fallen off or not.

Summary.

These experiments as yet provide no definite evidence on which opinions regarding the desirability of different plucking systems can be based. They show only the effects of different plucking in the first year, on this particular tea.

From first principles it would be expected that the more a bush is denuded of leaf, the more are flushes forced from it. The danger lies in the possibility of forcing beyond the capacity of the bush, but the effect of such forcing would probably not show up in the first year.

These experiments have yielded the unexpected result that it made remarkably small difference to crop whether plucking was started at 4 inches, 6 inches, or 8 inches, but above that height the bushes went *banjhi* and took some time to come through, meanwhile losing crop. It is believed that poorer bushes would have gone *banjhi* at lower levels and lost crop if plucked at 8 inches instead of 6 inches.

To leave a big leaf after tipping caused a distinct loss of crop approximating to 10 per cent. Observation after one year only cannot be of great value, but the guess is hazarded that a poor bush is more spared by plucking at such a height that it first goes *banjhi,* than by forcing growth by early tipping, even if a big leaf is left afterwards. It is suggested that when a section requires sparing, it would be better to spare it by leaving long initial growth, than by leaving afterwards; because the poor bushes would be more strengthened, while the good bushes would still yield a full crop. If a section is spared by leaving leaf after short initial growth the expectation is that crop would be lost from the good bushes, while the poorer bushes would not benefit so much.

In all cases leaf was lost by leaving big leave after tipping. The old system of leaving the same number of leaves all over the bush to produce a conical surface, lost crop by 6 per cent. compared to plucking flat at 6 inches, and was found most difficult to deal with in the field.

The variation in the crops obtained in different parts of the season, indicate interesting possibilities of adjusting plucking systems to produce maximum crop at seasons when it is most convenient to pluck it.

KHASI & JAINTIA HILLS

NORTH CACHAR

A. B. R.

Jatinga R.

Kayang

Jatinga Valley

Graigpark

Jalalpur

Kalainchara

Kukuri

N. W. CACHAR

Bikrampur

Balachara

Subhang

N. CACHAR

Jatinga R.

Surma R.

Singuri R.

Hilara

Boglia R.

Badarpur

A. B. R.

SYLHET

Salchapra

Silchar

Dalu

Rampur

Kalinagar

Khoril

Kanaikuri

Lursingd

HAPPY VALLEY

Dudpatli

Madhura R.

Dayapur

Chapanala

Arkatipur

Kasipur

Tarapur

Poloorband

Orunabund

Bandha

Goabari

Naga dung

Thaligram

Pathimara

Endogram

Khumbir

Tikakpur

Khumbirgram

Scottpur

Matichara

Purbal

Thaiu

Lydiachara

Balachan

Lalong

Dewan

Labac

Chiri R.

LAKHIPUR

Chinkuri

Katal

CHATLA

Barak R.

Bhorakhuri

Silkuri

BHEEL

Mamdha

Dilkhoosh

Tilkak

Alyne

Binnacherry

Chengjuri

Bhuban Valley

Didarkhosh

Narandhar

HILLS

Chanalpur

Barni Braes

Mukachapri

Mohanpur

Ratanpur

Dhaleswari R.

HAILAKANDI

Kalakhal R.

Rosekandi

Chota Jalinga

Bara Jalinga

Jhangmara

Derby

Bandukmara

Palai

Duarband

Noarband

Kalachara

Japirband Bagh o Bahar

Lalamukh

Lalachara

Varnerpur

Rupachara

Kathichara

Kukichara

Manipur

Sultanichara

Rukni

Rukni R.

Mayrakhal

Sonai R.

BHUBAN

MANIPUR

Barak R.

CHARGOLA VALLEY

Singra R.

SON BIL

Kanchanpur

Kayakhal

Singala

Kaya

Ramchandi

Apin

LUSHAI HILLS

SKETCH MAP
of
CACHAR
Scale 1 Inch = 4 Miles

0 5 10

Roads
District Boundary
Forest Reserve
High Land & Teela
Tea gardens marked in red and
Approximate positions shown thus

N

THE CACHAR DISTRICT.

Soil Survey.

BY

C. R. HARLER.

Geography and Geology.

The Cachar district consists of the three sub-divisions of North Cachar, Silchar and Hailakandi. Practically the whole of North Cachar is hilly country whilst the other two subdivisions are classed as plains. The Cachar tea gardens are all situated in the plains.

To the north, the Cachar tea district is bounded by the North Cachar Hills which are part of the Barail Range running from the Garo Hills to the head of the Brahmaputra Valley. The outlying spurs of this range are the sites of many tea gardens. The Bhuban Hills, a continuation of the Lushai system, form the eastern boundary. The Rengti Hills forming the southern boundary, also project from the Lushai system and are separated from the Bhubans by the broad valley of the Rukni and Sonai. These hills generally run northwards into the district and, with the Chhatachura range to the west, form the Hailakandi Valley. The Chhatchura Range forms the western boundary of the district and divides it from the Chargola Valley of Sylhet.

To the north of the tea district of Cachar, steep hills make tea planting impracticable. To the south, the tea areas usually extend as far as the Inner Line Forest Reserve.

Teelas or hillocks, which characterise the Surma Valley, are dotted over almost every portion of the plains of Cachar, except in the valley of the Sonai.

References: Assam District Gazetteers, Vol. I—Cachar.
Records Geological Survey of India, Vol. XXXI, pt. 4.
The Petroleum Occurrences of Assam and Bengal by E. H. Pascoe, Mem. Geol. Surv. India, Vol. XL, pt. 2.
Mem. Geol. Surv. India, Vol. I, pt. 2.
" " " " Vol. XIX, pt. 1.
" " " " Vol. XL, pt. 2.

The chief river is the Barak which rises in Manipur, and after completely changing its direction several times, eventually enters the plains and then follows a tortuous course through the centre of the district till it reaches Sylhet at Badarpur. In the cold weather, the Barak flows in a deep bed with banks rising 40 to 50 feet on either side. In the Monsoon, however, the river frequently overflows and floods the surrounding country.

On its north bank in Cachar the Barak receives the Jiri, Chiri, Madhura and the Jetinga as main tributaries from the North Cachar Hills. From the Lushai Hills in the south, flow the Sonai, the Dhaleswari and the Khatakhal.

Some account of the part these rivers play in the land-making process which is steadily going on, may be of interest. The Barak enters Cachar from the east, a considerable stream over-charged with silt. As soon as the rains set in, the Chatla and Hailakandi valleys turn into swamps (*bheels*) which discharge into the Barak. As this river, however, receives its freshets from the north and east it eventually rises above the level of the two valleys and pours its own floods into them, and a thick muddy current, heavy with silt, passes into the valleys and swells the *bheels* into wide lakes. When the big river subsides the streams again turn from the *bheel* to the Barak, having left behind a deposit of silt. With innumerable repetitions of this process, the bottom of the district is raised, and lakes turn into fens, fens shallow into reedy swamps, swamps into grassy praries. Every stage in the process may be witnessed in Chatla Bheel.

What has been going on in the large scale described has also gone on in many small flats now planted out with tea. Water has quietly backed up between the hillocks and deposited silt and clay but, in addition, the wash from the surrounding *teelas* has left further deposits.

The hills surrounding the Cachar district are sandstones of the Tertiary period. The spurs which run into the valley are

Tipam sandstones of the Pliocene age and, geologically speaking, very young rocks. The alluvium of the plains is derived almost wholly from the Tipam sandstones.

The core of the Khasia and Jaintia Hills, which adjoin the North Cachar Hills, is gneissic rocks of the Archean geological era, and the same age as the ancient rock forming peninsular India. During the successive upheavals and subsidences of this part of India and the frequent deposit of sediment during flooding, the original gneiss of the Shillong Plateau has become overlain with sandstones and conglomerates of the cretaceous age, which contain occasional coal seams. These, in turn, are overlain by beds of the Tertiary period, consisting of limestone and sandstone with interstratified shales and coal deposits.

The more recent deposits of the Tertiary period form the mass of the Barail Range in which is included the North Cachar Hills, although this section of the Range has not the ancient core of the Khasia and Jaintia Hills. These latter Hills have not been subject to such violent disturbances as the rest of the Range, and the sedimentary deposits are horizontal, and are clearly displayed at Cherrapunji. At Gujong, in the Mahur Valley a few miles to the west of the hill section of the Assam Bengal Railway, these recent deposits are still horizontal, or nearly so. In the valley of the Mahur the change from the generally undisturbed condition of the newer rocks on the Shillong plateau begins, whilst at Guilong, on the east side of the Mahur Valley, the strata are almost vertical. For a great part of the hill section the railway runs along the fault constituting the geological boundary between the Khasia and Jaintia Hills and the rest of the Barail Range. This fact accounts for much of the trouble arising from the subsidence of tunnels and cuttings on this section of the railway.

Cachar, like the rest of Assam, is a siesmic area. The most notable earthquake on record in Cachar occurred in 1869 which was attributed to a fissure about 20 miles long, situated at a considerable depth below the surface of the northern border

of the Jaintia Hills. Cachar escaped with little damage from the earthquake in 1897.

Cachar is in the oil belt running from Assam to the Arakan, through Cachar and Chittagong. The petroliferous beds occur in a series of Tertiary rocks known as the "coal measures" which are supposed to form domes or anticlines cropping out beneath the newer sandstones and sometimes faulted against the older Disang shale series on the east.

The Tea Areas.

Tea was discovered wild in Cachar in 1855. South of the Barak, Lushai or Cachar indigenous tea, which is a variety distinct from that of Assam proper, is found.

The first tea in Cachar was planted in 1856 in Mauza Barsangan on the low spurs running from the Barail Range to the Barak. The *teelas* south of the Barak were then planted, and in 1875 the first *bheels* were drained and opened out. In 1869, there were 24,151 acres under tea in Cachar yielding somewhat over 170 lbs. per acre. By 1882 the area had risen to 48,873 acres with an outturn of about 260 lbs. per acre. By 1898 the area planted was 62,179 acres yielding about 340 lbs. per acre.

The Cachar tea district is divided into six sub-districts of the Indian Tea Association, consisting of North-West Cachar, North Cachar, Happy Valley, Lakhipur, Chatla Bheel and Hailakandi. The area under tea is, at present, 55,685 acres yielding about 510 lbs. per acre.

The price of Cachar tea is about 4*d*. per pound less than that of the Assam Valley. This defect is due partly to the climate but principally to Cachar methods both in the field and factory. The plucking is generally coarse and long, and the subsequent care and treatment of the leaf during manufacture is usually far from ideal. It must be mentioned, however, that it is economically sound to make cheap, poor tea in Cachar, not only on account of lower costs but also because there is a

very definite demand for such a commodity. With the adoption of fine plucking and careful manufacture, Cachar gardens, other than *bheel* gardens, could be made to produce teas almost equal in quality to the Assam average.

Climate.

The climate of Cachar is more difficult for tea than that of Assam on account of higher temperatures and lower humidities during the dry season, especially to the south of the district. In the early part of the year, scorching winds occur which sometimes wither the bushes. In the rains, the topography of the country makes for heat and humidity, and, at this time, the tea grows and flushes with a vigour not seen in the Assam Valley.

The average maximum temperature at Silchar, which may be taken as indicative of that of the tea district, is 78°F. in January and 90°F. in July. The January value is 8°F. above that of Sibsagar, but the July values are the same in both places. The minima in January and July are 52°F. and 77°F. respectively. Here again the July figure is the same as that in Sibsagar, but the January value is 3°F. higher.

The rains break earlier in Cachar than in Assam and are considerably heavier. The benefit from this extra precipitation is reduced by higher temperatures and lower humidities in the dry season in the Surma Valley than in the Assam Valley.

The average monthly rainfall at Silchar and Tocklai is shown below, in inches.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Silchar	0·75	2·18	7·53	13.96	15·19	20·75	20·35	19·00	14·39	6·55	1·43	0·45	122·53
Tocklai	1·00	1·56	3·62	8·09	9·16	12·90	16·72	13·30	10·79	4·61	0·90	0·33	82·98

The Monsoon current blows into the Surma Valley from the south-west and then crosses the Hills to Assam where it augments the main current in the latter valley, which comes along the Brahmaputra. From East Bengal and South Sylhet, through Cachar to the North Cachar Hills there is a general

increase in rainfall followed by a decrease along the line of progress into Assam. As soon as the Brahmaputra Valley is reached and the rain shadow of the Mikir Hills left, the precipitation again increases on account of the rain brought by the main Monsoon current. The following total annual rainfall averages illustrate these points :—

Chandpur ...	Annual average rainfall ...			89	inches.
Habiganj ...	,,	,,	,, ...	99	,,
Hailakandi	,,	,,	,, ...	114	,,
Badarpur	,,	,,	,, ...	138	,,
Bikrampore	,,	,,	,, ...	164	,,
Nimotha	,,	,,	,, ...	203	,,
Mahur	,,	,,	,, ...	76	,,
Lumding	,,	,,	,, ...	50	,,
Golaghat	,,	,,	,, ...	78	,,
Sibsagar	,,	,,	,, ...	96	,,
Dibrugarh	,,	,,	,, ...	112	,,

Mahur is on the other side of the rain divide from Nimotha, and in the leeway of the hills.

Cachar Soil Types.

For practical purposes the Cachar tea areas are denoted as *teela*, plateau, *bheel* or flat and according to this division planting and general treatment varies. From the point of view of mechanical analysis the soils fall into two broad groups, the first of weathered soils of the *teelas*, and the second of soils washed from the *teelas*.

The *teelas* are generally sandy and have usually weathered considerably and, on this account, the clay fraction tends to become greater than the fine silt. The common *teela* type in Cachar is one in which fine sand is the greatest fraction, followed by coarse sand.

Nodular pans are common on *teelas* and, in some cases, a pan of such solidity occurs that planting is impossible. These pans are of chemical origin and consist largely of iron stone.

The nomenclature of soils adopted by this Department consists in a string of five numbers denoting the various fractions, placed in the order of magnitude of the fractions. Coarse sand is denoted by no. 1, fine sand by no. 2, silt by no. 3, fine silt by no. 4 and clay by no. 5. The soil analysis below, representing the commonest *teela* type, illustrates the use of this nomenclature.

Fraction.		Fraction number.
Coarse sand	25 %	1
Fine sand	45 %	2
Silt	15 %	3
Fine silt	5 %	4
Clay	10 %	5
Soil type ...	2, 1, 3, 5, 4.	

An approximate idea of the soil texture is obtained from the soil type alone, although the limitations of such a nomenclature are apparent. Thus the type 2, 1, 3, 5, 4, might represent a sand, as above, or a stiff soil in which all the fractions are present in almost equal quantity.

In soils which have weathered far, the clay fraction is generally greater than the fine silt and the order—5, 4 of these two fractions, in a sandy soil, usually denotes a soil formed *in situ*. In a stiff soil where the 5 and 4 fractions are major ones, the same order may also denote a weathered soil, but not necessarily, for by sedimentation it is possible to deposit fractions in the order 5, 4, 3, 2, 1. It is however impossible for running water to deposit a mixture of particles represented by 1, 5, 4, 3, 2, or 1, 2, 5, 4, 3, or 1, 2, 3, 5, 4, in which the coarser fractions are major ones to the—5, 4 combination. The subject of sedementation and soil formation is more fully discussed in *Quarterly Journal*, 1924, pt. 3, p. 134.

The extremely light sandy *teela*, common in Sylhet, is rare in Cachar. So far as the available analyses go it only occurs at Heroncherra (Ballacherra) and Majagram, north of the Barak although it is more common to the south of the river.

Many of the lightest *teela* areas north of the river have been abandoned. A typical light sandy *teela* analysis is shown below.

Fraction.	Fraction	number.
Coarse sand	40 %	1
Fine sand	32 %	2
Silt	7 %	3
Fine silt	5 %	4
Clay	11 %	5
Soil type ...	1, 2, 5, 3, 4.	

The second general division of Cachar soils includes the plateau soils, occuring mainly in the Happy Valley and Lakhipur north of the Surma. This type, however, is sometimes met south of the Surma where the areas are generally described as *teelas*. The plateau soils are much heavier than *teela* soils and appear to have been washed from the latter and subsequently raised or left as a plateau by subsidence of the surrounding areas.

When soil is washed from a hill, every conceivable mixture may accumulate at the bottom, according to the slope of the hill, the amount of the wash and the slope of the flat at the bottom of the hill. What has usually happened with the wash from the Cachar *teelas* is that most of the coarse sand has accumulated at the bottom of the *teela* and the other fractions have been carried on to form the soil of the flat. The result is that, on most flats, coarse sand is relegated from the position of a major fraction to a place usually at the end of the soil type chain. The finer fractions, silt, fine silt and clay, are proportionately increased and the fine sand has often only retained its original proportion, and not increased as the silts and clay, owing to the fact that some of this fraction remains behind with the coarse sand.

Two types of plateau soil are given, one from Burtoll, which fits in with what might be expected, and one from Koomber which is rarer and a type difficult to explain from considera-

tions of sedimentation and weathering, on account of the shortage of fine silt.

Fraction.	Fraction no.	Plateau soils.	
		Burtoll.	Koomber.
Coarse sand	1	11	7
Fine sand	2	17	15
Silt	3	24	27
Fine silt	4	14	4
Clay	5	25	38
	Soil type	5,3,2,4,1	5,3,2,1,4

The Burtoll sample might well come from a flat. Here both coarse and fine sand cease to be major fractions, and from the light, sandy original soil, a heavy type of loam is formed. The Koomber sample is quoted because of the curiously low fine silt fraction. Similar types, though with a larger silt fraction, occur elsewhere in Cachar.

The remarks on plateau soils generally apply equally to flat soils. In some cases, however, usually in narrow *kunchis*, the *teela* soil appears to have slipped *en bloc* into the valley and, owing to the very gentle slope of the latter, little subsequent sorting of the particles has occurred. In such cases, the flat soil gives an analysis practically the same as the original *teela*.

In some instances the water from flats has been unable to get away and a bog or *bheel* is formed, which, on draining, grows vigorous tea. The mechanical analyses of *bheels* resembles those of flats, but the organic matter content is very much higher.

In picturing the formation of flats, the issue is sometimes complicated by the fact that muddy rivers may have backed up the valley and deposited silts which become incorporated with the washed *teela* soil. In such cases, irregularities occur which cannot be explained by considerations of straight forward sedimentation or weathering.

The wide variation of flat soils makes it difficult to give typical examples. Usually flats contain at least three consecutive fractions in about equal quantities and are of the general types 1, 2, 3, or 2, 3, 4 or 3, 4, 5. The following are frequently met.

Fraction.	Fraction no.	Clay flat.	Medium flat.
Coarse sand	1	5	6
Fine sand	2	7	29
Silt	3	17	26
Fine silt	4	29	24
Clay	5	32	8
	Soil type	5,4,3,2,1	2,3,4,5,1

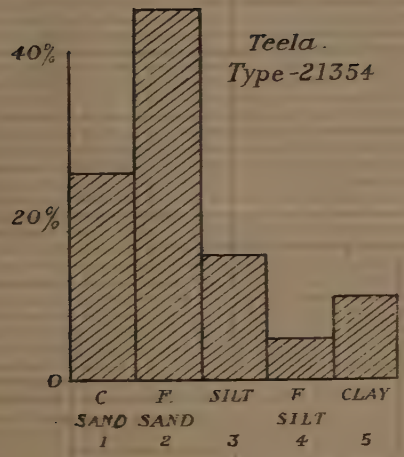
The commoner soil types met in Cachar are graphically represented opposite.

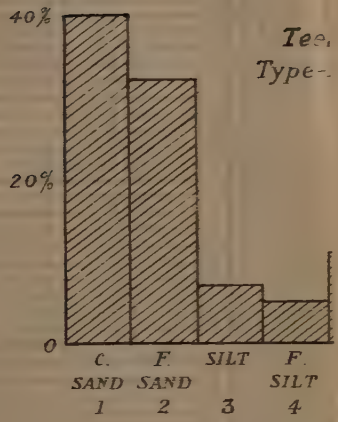
It is now necessary to consider the full analyses of some typical soils. The table below gives the mechanical and chemical analyses of a *teela* soil from Ballacherra, a plateau soil from Burtoll, a light sandy flat from Chandypore, a stiff flat from Lallamukh and a *bheel* from Derby.

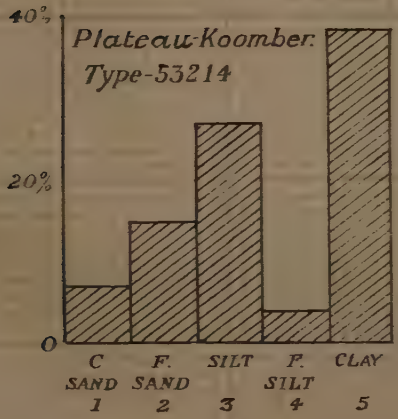
TYPICAL CACHAR TEA SOILS.

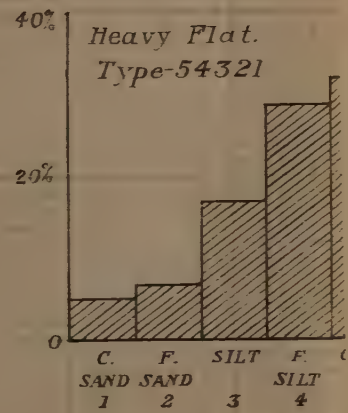
	Teela, Ballacherra.	Plateau, Burtoll.	Sandy flat, Chandypore.	Clay flat, Lallamukh.	*Bheel*, Derby.
	%	%	%	%	%
Mechanical Analysis—					
Coarse sand	25·3	12·9	5·0	16·4	23·5
Fine sand	38·6	30·8	43·4	14·0	7·5
Silt	15·2	26·6	23·3	17·9	8·2
Fine Silt	5·9	8·8	11·7	22·1	11·1
Clay	10·1	15·2	11·2	19·4	12·9
Loss on ignition	3·51	5·05	4·60	9·32	35·12
Soil Type	2,1,3,5,4	2,3,5,1,4	2,3,4,5,1	4,5,3,1,2	1,5,4,3,2
Chemical Analysis—					
Organic matter (Grandeau)	1·37	1·63	1·32	3·34	29·86
Insoluble silicious matter	88·42	84·40	86·96	74·45	54·80
Acidity (Hopkins)	1371	993	1439	4201	4785
Nitrogen	0·119	0·125	0·119	0·205	0·581
Available phosphoric acid	0·011	0·027	0·12	0·029	0·062
,, potash	0·008	0·005	0·008	0·008	0·028
,, lime	0·039	0·019	0·055	0·020	0·018

SOME CACHAR SOIL

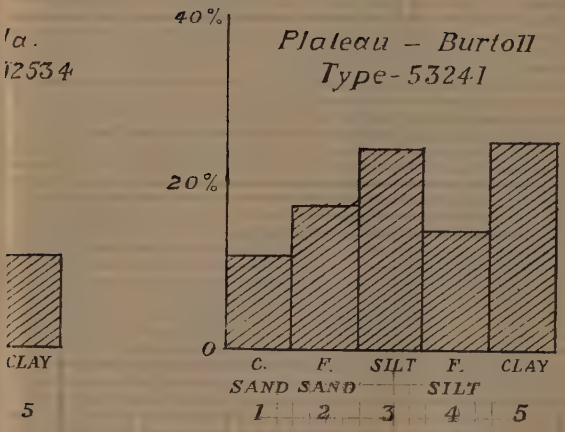




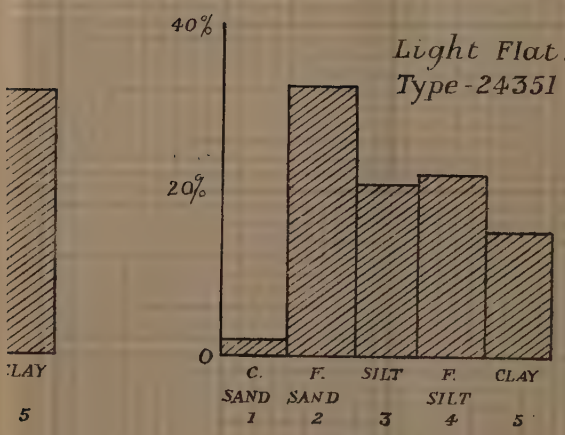




TYPES.



Plateau – Burtoll
Type-53241



Light Flat.
Type-24351

The loss on ignition is some measure of the total organic matter in the soil, whilst the organic matter estimated by the Grandeau method may be taken as an indication of the degree of rotting of the organic matter. The insoluble silicious matter is largely quartz and indicates inactive mineral matter not entering the soil solution. This value is usually highest in the sandiest soils. The available potash, phosphoric acid and lime must be considered in relation to the amount of insoluble, non-silicious matter for, the smaller this quantity, the lighter the soil usually, and consequently the greater the root range of the bush. The result is that soluble quantities of plant food indicating a poor soil in the case of a clay, may indicate a very good soil in the case of a sand.

The acidity values are those estimated by the Hopkins method, the full interpretation of which is difficult and it is impossible to denote any figure as a safe acidity value. Other acidity constants, the pH value of the soil solution and the pH value of the nitrate of potash extract, are of more use and generally distinguish between good and bad tea soils. The determination of these constants is, at present, not included in a soil analysis made by the Calcutta analysts. Many of these estimations are, however, made at Tocklai and, in the case of a soil showing a very low or very high Hopkins acidity, we prefer to make pH determinations before suggesting manurial treatment.

The term *bheel* is taken, locally, to denote a flat rich in organic matter but, in its general sense, a *bheel* area is a drained fen or bog. The peat *bheels* after some years often deteriorate either by sinking below the drainage level or by being overdrained. In the latter case, alternate seasonal wetting and drying eventually robs the colloidal matter in the soil of its stickiness, and the *bheel* becomes " fluffy " and difficult to wet.

When a rich flat deteriorates for reasons not connected with drainage, a loss of organic matter and nitrogen is generally observed. Liberal manuring is the only remedy.

When a coarse sandy *bheel* deteriorates it does not go "fluffy" but usually dries out and the tea suffers during the dry season. These deteriorated soils are often characterised by a high phosphoric acid and low potash content and high acidity. Such areas are usually liable to severe mosquito attack, probably on account of the drought effect but possibly also by reason of the deficiency in potash. The judicious application of potash manures in such cases may increase the resistance of the bush to mosquito attack.

When *teelas* are top dressed with *bheel* soil the first results are beneficial. After a time, however, the organic matter and nitrogen in the soil are partially dissipated and the tea begins to deteriorate. *Teela* soils, on top dressing, show a very great increase in soil acidity, the value rising from about 1,000 to 4,000 or 5,000. As the area deteriorates the acidity does not appear to change and on such areas the application of lime in small doses should do good.

The Manurial Treatment of Cachar soils.

In considering the manurial treatment of Cachar soils or, in fact, of practically any tea soil in North-East India, it may be assumed that the addition of nitrogenous manures will increase the crop. The only definite experiment made on a peat *bheel* showed that this also responded to additions of nitrogen, although it is usually stated that *bheels*, rich in peat, do not require manuring.

The nitrogenous manures now on the Calcutta market include sulphate of ammonia, nitrate of soda, nitrate of potash, calcium cyanamide, animal meal, cake and blood meal. The last three manures are of an organic nature and expensive. Of the others, sulphate of ammonia and calcium cyanamide are cheap and have been proved to give good returns. In most cases the use of one or the other of these manures is suggested.

With the high temperatures and humidities ruling in North-East India the dissipation of organic matter from the soil is rapid, especially where the bushes are not big enough to

protect it from the direct rays of the sun. In such areas, the addition of organic matter in bulk, either as cattle manure or green crop, is essential. On areas where the tea is touching, the leaves shed from the bush supply much organic matter, but the addition of further supplies in the form of Boga medeloa is advisable in many cases. Well shaded areas of fully grown tea can be left without green crops if labour is short. When an area is cut back the opportunity of growing as many green crops as possible should be taken.

Any manurial cycle, then, must include frequent doses of nitrogen with green crops or cattle manure as often as possible.

In considering the potash and phosphoric acid requirements of our tea soils, experience has shown that the heavier soils need more phosphoric acid than the lighter ones and the lighter soils need more potash than the heavy ones.

Another factor for consideration in applying manures is the soil reaction. Tea does best on soils showing an acidity of about pH = 5.4. The continued application of acid manures like sulphate of ammonia to soils already strongly acid is not good. On the other hand the continued application of alkaline manures like calcium cyanamide to soils of a slightly acid nature is to be avoided. The careful use of acid and alkaline manures should keep the soil reaction at a suitable figure.

Another point to consider is the manurial treatment of green crops. These thrive on phosphatic manures and on lime. Hence, at the time of sowing, a dose of phosphoric acid should be given. Tea itself does not usually require lime, but, calcium cyanamide when it decomposes yields somewhat more than its own weight of limestone. It follows then, that, in a manure cycle, this fertilizer may, with advantage, be added the year before green cropping. If it be added the year of green cropping, the application should be made well ahead of the sowing of the green crop, because this manure is liable to kill seedlings when it is first applied.

Bearing these principles in mind, a manurial programme may be constructed. Four cases are considered below, two for clays and two for sands. A soil containing above 10 per cent. clay may generally be treated as a clay although the percentages of the other fractions should also be taken into account. For both types of soil two programmes are given, one for areas where ground green crops like cowpeas or dhaincha can be grown and one where the tea is too big to allow of such growth.

The rates refer to applications per acre. The manures should be broadcast except in cases where the root area is so limited that much of the manure may be lost to the bush by this method of application. In these cases the manure should be forked round the bush.

The applications, except in the case of calcium cyanamide, are usually made in April. Cattle manure may be applied whenever labour is available.

CLAY SOILS.

With ground green crops.	*Without ground green crops.*
A. Calcium cyanamide, 2 cwt. per acre, Feb. or March.	Same as opposite.
B. Alphos, 2 cwt. per acre, broadcast up lines before sowing ground green crops *or* cattle manure, 5 tons per acre.	Cattle manure, 5 tons per acre or Oilcake, 8 mds. per acre *or* Sulphate of ammonia, 2 cwts. Muriate of potash, ½ cwt. Superphosphate, 1½ cwts. per acre in March or April.
C. Sulphate of ammonia, 2 cwts. Muriate of potash, ½ cwt. Superphosphate, 1½ cwts. in March or April.	Same as opposite.
D. Boga medeloa in every third row. Lop fre-	

quently and thin out to clumps at end of season, *or* Rahar in alternate rows, lop frequently. Bury at end of season.	Same as opposite.
Calcium cyanamide 2 cwts. per acre in February.	
E. Sulphate of ammonia, 2 cwts. Muriate of potash, ½ cwt. Superphosphate, 1½ cwts. in March or April.	Same as opposite.

SANDY SOILS.

With ground green crops.	*Without ground green crops.*
A. Sulphate of ammonia, 2 cwts. Sulphate of potash, ½ cwt. in March or April.	Same as opposite.
B. Alphos, 1½ cwt. per acre broadcast up lines before sowing ground green crops *or* Cattle manure, 5 tons per acre.	Cattle manure, 5 tons per acre *or* Oilcake, 2 mds. per acre. *or* Sulphate of ammonia, 2 cwts. Sulphate of potash, ½ cwt. Superphosphate, 1½ cwts. in March or April.
C. Sulphate of ammonia, 2 cwts. Sulphate of potash, ½ cwt. in March or April.	Same as opposite.

D. Boga medeloa in every third row. Lop frequently and thin out to clumps at end of season *or* Rahar in alternate rows. Bury at end of season.	Same as opposite.
Sulphate of ammonia, 2 cwts. Sulphate of potash, ½ cwt. Superphosphate, 1½ cwts. in March or April.	
E. Calcium cyanamide, 2 cwts. in February. Bury Boga medeloa at end of season.	Same as opposite.

The cost of these programme works out at about Rs. 19 per acre, per annum, for the Calcutta purchases, excluding cost of seed for green crops or freight and application of mixtures. This is the minimum expenditure advised. The careful carrying out of such a programme will give an increase at the end of five years of at least 25 per cent. above what the area would have been giving if it had been left unmanured. This does not indicate that the crop will necessarily increase above its present value to that extent. The general tendency with fully developed tea is for the crop to fall off gradually and, if the rate of decrease is a cumulative 5 per cent. per annum, a manuring cycle may only keep pace with this and the crop will remain stationary.

For the detailed use of a manuring cycle reference should be made to the *Quarterly Journal*, Part II, 1924, and for suggestions on the treatment of *bheels* the reader is referred to the *Quarterly Journal*, Part IV, 1922, p. 152.

It is not suggested that the manure cycles outlined above should be taken as they stand and applied to any garden, for

there are minor conditions on most areas requiring some modification of the broad principles. These modifications can be learned by application to Tocklai.

Below is given, as an appendix, the mechanical analyses of soils from the various Cachar gardens. In many cases all the available analyses are given, but in others, where samples from similar areas have been taken, only typical analyses are quoted. The figures are percentages, given in the case of the soil fraction to the nearest unit. Partly on this account and also because the matter soluble in dilute acid is omitted, the percentages often add up to something less than 100.

ANALYSES OF CACHAR SOILS.

North-West and North Cachar.

Jellalpur, the most westerly of the Cachar gardens, shows three type of sandy loams.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Jellalpur No. 1	21	29	9	15	21	5·23	2, 5, 1, 4, 3
,, No. 2	20	21	15	16	22	5·45	5, 2, 1, 4, 3
,,	27	28	10	19	12	3·49	2, 1, 4, 5, 3

At Kallinecherra the samples are variations of heavy and light silts and of interest because the silt fraction (no. 3) seldom occurs as a major fraction in the tea soils in North-East India.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Kallinecherra							
No. 4 Dhip	16	17	42	12	9	3·55	3, 2, 1, 4, 5
,, No. 2 Kch.	4	23	23	26	18	5·39	4, 2, 3, 5, 1
,, No. 3 Kch.	5	22	31	16	4	5·55	3, 2, 4, 1, 5

Silts, especially clay silts like no. 2 above, are difficult to work and are only kept friable by the addition of bulky organic matter.

At Craigpark occur soils formed by weathering and also deposited by water in some geologically recent time. The

weathered soils are represented by the first two, in which the clay and fine silt fractions occur in the order—5, 4, and—5, 1, 4. The second sample is a much richer soil than the first.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Craigpark No. 8	6	34	36	7	13	4·36	3, 2, 5, 4, 1
,, No. 3 Ballicherra	16	26	25	5	19	7 95	2, 3, 5, 1, 4
,, A.	11	52	21	10	6	3·38	2, 3, 1, 4, 5
,, B.	21	45	14	17	4	2·48	2, 1, 4, 3, 5
,, C.	13	44	30	9	4	3·93	2, 3, 1, 4, 5

At Kalline, all the samples except the last are of the stiff, silt-clay type. The last sample is of the—2, 4 type with fine sand and silt as major fractions. Soils of this type are usually hard and "steely" in the cold weather.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Kalline, Anush No. 4	2	23	30	21	18	4·70	3, 2, 4, 5, 1
,, No. 9	1	3	20	39	28	6 07	4, 5, 3, 2, 1
,, No. 10	9	18	16	21	26	7·83	5, 4, 2, 3, 1
,, No. 13	3	14	33	22	20	5·49	3, 4, 5, 2, 1
,,	9	28	18	26	15	4·14	2, 4, 3, 5, 1

At Kurkoorie several very distinct types occur, from light sands to stiff clays, with intermediate loams.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Kurkoorie	8	61	16	8	4	2·22	2, 3, 4, 1, 5
,,	14	43	18	12	10	4·23	2, 3, 1, 4, 5
,,	19	30	17	11	17	6·33	2, 1, 3, 5, 4
,,	1	9	26	38	19	5·81	4, 3, 5, 2, 1
,,	5	42	25	15	10	4·02	2, 3, 4, 5, 1

The second and third samples are physically the best, containing, as they do, good proportions of fine and coarse particles, the former for food supply and the latter to keep the soil open and tractable.

At Bikrampore occur both the sandy type usually met on *teelas* and the heavy flat type. The description of the soils, however, given on the analysis forms, does not indicate the nature of the area.

It may be mentioned here that, at Tocklai, a full description of an area is appreciated when we are devising manure programmes, and soil samples marked alphabetically or numerically are not so helpful as a descriptive marking indicating the section number and the nature of the area, whether *teela,* flat or *bheel.* In most cases, insufficient marking of soil samples makes it necessary for us to guess at the probable nature of the area.

Soil mark.	Coarse sand.	Fine sand	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Bikrampore ...	2	19	29	27	17	4·90	3, 4, 2, 5, 1
,, ...	30	39	10	11	7	2·41	2, 1, 4, 3, 5
,, ...	27	38	11	12	9	8·85	2, 1, 4, 3, 5
,, ...	20	38	14	15	9	3·34	2, 1, 4, 3, 5

Crossing into North Cachar, the first garden of which analyses are available is Ballacherra. Both the normal sandy *teela* and the heavier silt flat soils occur.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Ballacherra H. 22 ...	9	30	16	10	26	8·36	2, 5, 3, 4, 1
,, Khasia flat	*nil*	24	32	25	13	4·67	3, 4, 2, 5, 1
,, Office flat...	15	40	22	8	9	4·92	2, 3, 1, 5, 4
,, Oraon flat	8	29	32	12	11	5·05	3, 2, 4, 5, 1
,, Rasta flat...	2	14	41	15	9	7·41	3, 4, 2, 5, 1
Sonacherra No. 1 ...	6	37	30	12	20	3·58	2, 3, 5, 4, 1
Heroncherra H. 1 ...	25	21	21	7	17	6·71	1, 2, 3, 5, 4
Panicherra No. 1 .	25	39	15	6	10	3 51	2, 1, 3, 5, 4

All but the first, fourth and fifth soils are from flats. The *teela* soils all exhibit the—5, 4, grouping as does also the Ballacherra Office Flat sample although not in a marked degree.

Doloo is on the plateau stretching from this garden across to the extreme east of the Cachar district. The plateau soils

are usually heavier than the *teela* soils, and the probable formation of this area may account for this. Thus, it is likely that what is now plateau was washed from the North Cachar Hills to form a flat. Subsequent upheaval of this flat or subsidence or erosin of the lands to the south, formed a plateau. Frequently, near the plateau, true *teela* land is met and then the usual *teela* soil type occurs.

Plateau soils form the greater part of the high land in the Happy Valley and in the part of Lakhipur, north of the Surma. These soils often contain large rocks of sandstone and shale, with the interstices filled with the stiffish soil common to the plateau.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Doloo	15	26	25	11	15	6·38	2, 3, 5, 1, 4
Hatticherra ...	32	36	6	9	11	5·56	2, 1, 5, 4, 3
Rampore No. 2 ...	19	35	15	16	10	4·91	2, 1, 4, 3, 5
„ No. 3 ...	18	36	16	15	9	4·60	2, 1, 3, 4, 5
„ No. 4 ...	14	31	19	17	12	5·51	2, 3, 4, 1, 5
„ No. 5 ...	16	40	13	15	10	5·71	2, 1, 4, 3, 5
„ No. 6 ...	12	29	13	19	20	6·43	2, 5, 4, 3, 1

The Doloo sample exhibits the—5, 4, combination of a weathered soil but is heavier than the normal *teela*.

Khoreeal and Kallynugger are partly on the plateau and partly on *teela* and flat.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Khoreeal—Kopibari ...	5	23	39	12	15	5·16	3, 2, 5, 4, 1
„ No. 1 *teela*...	6	23	38	8	15	6·76	3, 2, 5, 4, 1
„ Kallynugger	17	32	19	8	19	4·80	2, 3, 5, 1, 4
„ Kona *teela* ...	17	25	13	8	30	7·18	3, 2, 4, 5, 1
„ No. 9 flat ...	5	19	44	14	12	6·70	5, 2, 1, 3, 4
„ No. 9 Kallynugger ...	28	32	11	4	9	5·07	2, 1, 3, 5, 4

The Kopibari sample is a narrow flat between high *teelas* and probably consists of *teela* soil washed down and deposited *en bloc*. This sample is identical with No. 1 *teela*. The

Kallynugger and Kona *teela* samples are both described as plateau lands.

The Happy Valley District.

This sub-district consists of the Koomber plateau and the lines of teelas which extend to the Barak River. At Koomber itself the soils are heavy clays almost devoid of fine silt.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Koomber ...	7	15	27	4	38	8 96	5, 3, 2, 1, 4
„ ...	16	26	21	4	27	6 31	5, 2, 3, 1, 4
Teckulpar ...	*nil*	5	43	17	27	6·39	3, 5, 4, 2, 1
Burratoll No. 10 ...	21	34	10	16	13	4·60	2, 1, 4, 5, 3
Sunatallah ...	12	17	15	24	23	7·85	4, 5, 2, 3, 1
Kumbargram No. 3 ...	9	17	30	7	25	10·52	3, 5, 2, 1, 4

The Teckulpar sample also resembles the plateau type being too heavy for the average *teela* whilst the two samples following are of the type met on flats. The Koombergram samples resembles those of Koomber.

At both Pathemara and Pathecherra the soils are of the washed type.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Pathemara No. 2 ...	6	16	15	39	13	8·25	4, 2, 3, 5, 1
„ No. 15 ...	8	28	20	29	7	5·85	4, 2, 3, 1, 5
„ No. 24 ...	9	30	25	21	7	6·75	2, 3, 4, 1, 5
„ Augustnugger „ No. 1 ...	26	32	12	17	9	3·02	2, 1, 4, 3, 5
„ Siburband No. 13 ...	2	7	36	25	25	6·14	3, 5, 4, 2, 1

At Goabarrie, north of the plateau, and in the hills the soil is of the typical *teela* type 2, 1, 5, 4, 3.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Goabarrie China No. 2	18	39	10	13	14	4·73	2, 1, 5, 4, 3
„ No. 5 ...	23	37	6	13	16	4·30	2, 1, 5, 4, 3

From Cherrie Valley (Annacherra and Martycherra) the samples display the *teela*, the flat and the plateau type, the last denoted by a shortage in the fine silt fraction.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Annacherra ...	24	38	17	7	10	3·39	2, 1, 3, 5, 4
,, No. 18 ...	23	27	20	9	8	3·33	2, 1, 3, 4, 5
Martycherra No. 3 ...	16	20	22	6	28	5·75	5, 3, 2, 1, 4
,, No. 10 ...	17	21	25	15	14	5·77	3, 2, 1, 4, 5

The first sample from Annacherra is typical *teela*.

Since the flat and plateau types are similar it is difficult to say, definitely, whether a section is flat or plateau without local information. Thus at Endogram the only soil analysis available is of the flat type. At Thaligram, on the opposite side of the Koomber plateau, the soils are variations of the flat type, with the coarse sand as the smallest fraction. The sample, Thaligram no. 14, is described as *teela*, but its analysis suggests plateau land. Thaligram no. 1 also appears to be a washed soil in spite of its fair proportion of coarse sand. At Nagadoom several samples, very similar, all appear to be flats except the last sample which is a *teela* type.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Endogram ...	7	22	18	17	26	7·58	5, 2, 3, 4, 1
Thaligram B. 13 ...	1	18	16	36	22	5·46	4, 5, 2, 3, 1
,, D. 14 ...	2	34	20	20	17	4·94	2, 3, 4, 5, 1
,, No. 14 ...	4	26	17	22	23	6·00	2, 5, 4, 3, 1
,, No. 1 ...	10	38	12	19	14	5·30	2, 4, 5, 3, 1
Nagadoom No. 1 ...	8	29	19	21	18	4·16	2, 4, 3, 5, 1
,, No. 1 Tingtang ...	20	35	7	14	16	5·57	2, 1, 5, 4, 3

On the other side of the Madhura River, soil analyses from Chandighat and Larsingah are available. The Chandighat analyses show *teelas* of varying degrees of heaviness and flats. From Larsingah some of the samples resemble the Koomber soils in their shortage of fine silt. Some of the samples described as

teelas are representative of plateau soils. The samples below are typical of the large number of analyses available.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Chandighat ...	8	14	22	16	30	8·60	5, 3, 4, 2, 1
„ ...	17	23	16	15	21	6·40	2, 5, 1, 3, 4
„ ...	9	13	18	15	34	9·61	5, 3, 4, 2, 1
„ ...	21	32	14	11	16	4·95	2, 1, 5, 3, 4
„ ...	14	30	17	14	18	5·76	2, 5, 3, 1, 4
„ ...	2	40	21	19	13	4·02	2, 3, 4, 5, 1
Larsingah ...	3	4	31	22	32	7·21	5, 3, 4, 2, 1
„ Kookee *teela* No. 3 ...	11	23	26	9	25	6·15	3, 5, 2, 1, 4
„ Kookee *teela* No. 6 ...	26	27	17	7	18	4·50	2, 1, 5, 3, 4
Chotasingah No. 12 ...	11	13	25	15	28	7·37	5, 3, 4, 2, 1
„ Line *teela*	11	13	15	18	34	8·23	5, 4, 3, 2, 1
Barasingah flat No. 10	17	25	15	16	21	5·23	2, 5, 1, 4, 3
New Bhotan *teela* ...	11	16	17	15	31	7·74	5, 3, 2, 4, 1

To the south-west of the Koomber plateau runs a string of *teelas* among which Urrunaband, Doyapur, Chapannala, Majagram, Arkatipur and Cossipur are put out. The following analyses are available, indicating ordinary *teela* and flat.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Urrunaband ...	6	26	17	24	19	7·71	2, 4, 5, 3, 1
Doyapore No. 3 *bheel*	1	3	12	44	20	19·65	4, 5, 3, 2, 1
„ 1911 *teela*	20	41	12	11	10	5·77	2, 1, 3, 4, 5
Majagram No. 7 *teela*	36	19	12	9	19	4·99	1, 5, 2, 3, 4
„ No. 9 flat ...	11	23	31	10	17	7·25	3, 2, 5, 1, 4
Durgannugger No. 7 flat	18	19	26	10	14	11·76	3, 2, 1, 5, 4
„ No 2 „	10	9	11	28	14	25·57	4, 5, 3, 1, 2
„ No. 5 „	8	6	26	23	21	14·87	3, 4, 5, 1, 2
Cossipore ...	1	4	18	35	32	7·92	4, 5, 3, 2, 1

The Lakhipur District.

The Lakhipur district is a large one, including part of the Koomber plateau and the area between the Labac and the Chiri Rivers and also the gardens south of the Surma bordering on the Bhuban range. Unfortunately few analyses are available.

The first convenient group of gardens to consider includes Scottpore, Doloogram, Budlicherra, Pallorbund and Narainpore,

since these start at the plateau and are included in the line of *teelas* and raised land which extends to the south.

Both the Scottpore samples are of *bheels,* albeit poor in organic matter, and, as such, show the analyses of flat areas. From Doloogram both *teela* and flat analyses are shown. The Budlicherra samples suggest flats. The Narainpore soils are of the type formed by weathering, in which coarse and fine particles form major fractions.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Scottpore bheel No. 1...	8	42	18	19	8	5·30	2, 4, 3, 1, 5
„ „ No. 2...	3	44	16	21	10	5·13	2, 4, 3, 5, 1
Doloogram, Manipuri *teelas* ...	13	35	21	10	16	4·62	2, 3, 5, 1, 4
„ Iringmara Narain flats	3	41	26	12	12	4·15	2, 3, 4, 5, 1
„ Lattigram flat ...	12	31	22	11	16	6·02	2, 3, 5, 1, 4
„ Pollarband *kunchi* ...	14	18	15	21	12	17·20	4, 2, 3, 1, 5
Budlicherra No. 19 ...	11	20	21	12	25	10·54	5, 3, 2, 4, 1
„ No. 18 ...	11	16	20	14	31	7·57	5, 3, 2, 4, 1
Pollarband, Doloogram *kunchi* ...	33	39	11	9	4	2·46	2, 1, 3, 4, 5
„ M. P. *kunchi*	20	43	12	13	7	5·42	2, 1, 4, 3, 5
„ No. 6 flat...	36	22	9	16	9	6·26	1, 2, 4, 3, 5
„ Singlo *kunchi* ...	28	31	11	15	7	6·48	2, 1, 4, 3, 5
Narainpore 1912 ...	16	12	8	18	22	23·23	5, 4, 1, 2, 3
„ "18 acres"	18	29	16	16	17	4·45	2, 1, 5, 3, 4

As previously mentioned, plateau soil types seldom occur south of the Surma and the *teelas* and spurs coming from the North Cachar Hills are less sandy than those related to the Lushai Hills. The North Cachar Hills are generally richer in shales (laminated clays) than are the hills on the other side of the Surma and it is likely that, on this account, the plateau soils are more consistently heavy than flat soils washed from the *teelas* in the neighbourhood of the Lushai Hills.

Plateau soils frequently exhibit no. 5 (clay) and no. 2 or no. 3 (fine sand or silt) as major fractions. At both Burtoll and Dewan the general —5, 3, 2 type occur.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Burtoll 1 ...	11	17	24	14	25	7·17	5, 3, 2, 4, 1
„ 2 ...	16	15	24	14	24	7·52	3, 5, 1, 2, 4
„ Lyd. A ...	1	16	47	12	18	5 05	3, 5, 2, 4, 1
„ „ B ...	16	19	32	6	21	6 71	3, 5, 2, 1, 4
„ „ E ...	7	17	27	13	29	7·67	5, 3, 2, 4, 1
„ „ F ...	2	4	40	26	22	6·29	3, 4, 5, 2, 1
„ Bal. 1 ...	1	8	47	14	23	6·29	3, 5, 4, 2, 1
„ „ 2 ...	1	34	43	8	11	3·50	3, 2, 5, 4, 1
„ „ 3 ...	22	31	24	4	5	5·83	2, 3, 1, 5, 4
„ No. 5 J ...	13	31	27	9	15	5·05	2, 3, 5, 1, 4
„ No. 6 B ...	13	21	27	6	26	5 66	3, 5, 2, 1, 4
„ No. 3 B ...	15	29	31	5	13	5·35	3, 2, 1, 5, 4

At Labac the —5, 3 type does not occur.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Labac No. 7 flat ...	21	25	8	5	36	5·26	5, 2, 1, 3, 4
„ Narainpore *bheel*	2	3	19	39	26	10·98	4, 5, 3, 2, 1
„ No. 15 flat ...	24	19	14	9	19	4 59	1, 2, 5, 3, 4
„ No. 8 *bheel* ...	1	4	7	33	42	12·15	5, 4, 3, 2, 1
„ No. 7 old ...	21	25	24	6	19	4·46	2, 3, 1, 5, 4
„ No. 12 flat ...	7	15	14	33	21	8·89	4, 5, 2, 3, 1
„ No. 12 *teela* ...	3	25	19	24	22	6·22	2, 4, 5, 3, 1
„ sandy flat ...	9	59	16	9	4	2·35	2, 3, 4, 1, 5

At Dewan there are, broadly speaking, two types, one the —2, 4, in which fine sand and fine silt are major fractions and the other of the —5, 3 or —2, 5, 3 type with the fine silt (grade 4) at the end of the chain. The second type resembles the Koomber plateau soils. The two types occur on all the divisions of Dewan.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine salt.	Clay.	Loss on ign.	Soil type.
Lallong No. 2 ...	9	33	17	19	14	6·19	2, 4, 3, 5, 1
„ No. 7 ...	11	32	4	26	21	5·78	2, 4, 5, 1, 3
„ ...	18	22	21	8	22	6·68	2, 5, 3, 1, 4
Thailu No. 2 ...	6	23	24	25	14	7·52	4, 3, 2, 5, 1
„ No. 23 ...	9	30	17	21	15	7·53	2, 4, 3, 5, 1
„ ...	18	20	22	6	25	7·19	5, 3, 2, 1, 4
Bundoo No. 4 ...	7	23	20	26	17	8·27	4, 2, 3, 5, 1
„ ...	13	19	25	8	26	7·83	5, 3, 2, 1, 4
Dewan ...	17	22	25	11	20	6·15	3, 2, 5, 1, 4
„ No. 8 ...	10	33	19	17	15	6·02	2, 3, 4, 5, 1

The gardens south of the Surma may now be considered. At Binnakandi extreme types are met including very heavy clays and light sands.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Binnakandi Hattikuri	1	3	8	34	35	17·77	5, 4, 3, 2, 1
„ plateau re-planted ...	25	39	12	11	10	3·52	2, 1, 3, 4, 5
„ Gobindthal	17	59	9	8	4	2·5	2, 1, 3, 4, 5
„ Hattikuri No. 3 ...	7	40	29	15	8	3·63	2, 3, 4, 5, 1
„ Rungthal No. 1 ...	22	12	10	16	21	7·46	5, 1, 4, 2, 3
„ Rungthal No. 1 ...	2	13	12	29	13	28 98	4, 2, 5, 3, 1

The remaining analyses of this area are as follows :—

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Tilkah No. 11 ...	4	19	20	34	16	6·77	4, 3, 2, 5, 1
„ No. 93 ...	3	27	16	29	17	8·39	4, 2, 5, 3, 1
Bhubandhar ...	*nil*	27	26	23	15	7·36	2, 3, 4, 5, 1
„ ...	*nil*	34	15	29	15	6·59	2, 4, 5, 3, 1
Bhuban Valley No. 6	1	8	20	35	25	9·85	4, 5, 3, 2, 1
„ „ No. 6	6	42	18	17	10	7·49	2, 3, 4, 5, 1
„ „ No. 3C.	7	55	14	12	6	4·72	2, 3, 4, 1, 5
„ „ No. 6 C.E.M.	12	51	12	15	15	5·60	2, 4, 5, 3, 1
„ „ No. 3 C.E.S.	1	2	12	38	27	18·68	4, 5, 3, 2, 1
Chingoor No 10 ...	4	10	15	39	18	9·0	4, 5, 3, 2, 1
North Bank No. 8 ...	32	22	15	17	9	4·34	1, 2, 4, 3, 5
„ No. 9 ...	3	41	16	19	13	5·7	2, 4, 3, 5, 1

Chatla Bheel.

Silcoorie, Borokai and Dhurum Khall gardens may first be considered. Many analyses of Silcoorie are available, showing typical *teela* soils and flats. In two cases the flat soils might be mistaken for *teelas*, *i.e.*, Titumia and Baja flats, although in both cases the clay is somewhat higher than is usually found in *teela* soils. Both Dhurum Khall samples are of *bheels*.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Silcoorie No. 4 flat	2	11	20	25	34	6·44	5, 4, 3, 2, 1
,, Kanki flat ...	11	36	20	15	13	3·98	2, 3, 4, 5, 1
,, Ghar *teela* ...	10	43	16	11	16	4·14	2, 5, 3, 4, 1
,, Jungli flat ...	5	18	31	21	19	4·48	3, 4, 5, 2, 1
,, ,, *teela* ...	46	20	10	7	13	3·66	1, 2, 5, 3, 4
,, Titumia flat	21	31	13	12	18	4·06	2, 1, 5, 3, 4
,, Derby Clearance ..	53	19	8	3	4	1·92	1, 2, 3, 5, 4
,, Hira *teela* ...	20	22	19	13	20	3·31	2, 1, 5, 3, 4
,, South flat ...	6	35	24	18	13	3·07	2, 3, 4, 5, 1
,, Baja flat ...	27	32	15	8	14	3·65	2, 1, 3, 5, 4
,, No. 8 flat ...	13	51	19	7	8	2·80	2, 3, 1, 5, 4
,, No. 12 flat ...	9	24	22	21	19	3·63	2, 3, 4, 5, 1
,, Bunglow *teela*	33	28	13	6	16	3·74	1, 2, 5, 3, 4
Borokai ...	30	33	7	10	12	4·53	2, 1, 5, 4, 3
Dhurma Khall Kalacherra flat ...	1	16	17	36	8	16·73	4, 3, 2, 5, 1

Derby and Poloi are on either side of a low spur running from the Lushai Hills. The Derby soils are mostly *bheels*.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Derby—Poloi *kunchi*	34	31	10	12	8	4·48	1, 2, 4, 3, 5
,, No. 2 ...	27	11	8	17	22	14·23	1, 5, 4, 2, 3
,, No. 4 ...	7	15	19	24	25	7·36	5, 4, 3, 2, 1
,, No. 9 T. P. ...	23	8	9	11	13	35·12	1, 5, 4, 3, 2
,, No. 5 P. B. ...	17	12	13	9	12	36·18	1, 3, 2, 5, 4
,, No. 5 P. B. ...	14	20	18	17	21	9·01	5, 2, 3, 4, 1
,, No. 3 B. ...	17	3	7	8	41	22·61	5, 1, 4, 3, 2

At Poloi the soils are various types of flats, some of the samples coming from good and some from poor areas. The latter are usually lacking in organic matter. The analyses shown are typical of the great number available.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Poloi, good ..	1	14	15	33	30	8·66	4, 5, 3, 2, 1
,, bad ...	5	47	14	15	13	3·95	2, 4, 3, 5, 1
,, Line flat, bad ...	6	33	27	25	5	4·13	2, 3, 4, 1, 5
,, ,, ,, good ...	4	22	19	30	18	7·42	4, 2, 3, 5, 1
,, Banakhall S. *kunchi* ...	10	6	28	22	24	10·02	3, 5, 4, 1, 2
,, Banakhall N. *kunchi* ...	27	6	19	14	13	19·43	1, 3, 4, 5, 2
,, Tewari flat ...	8	24	27	13	21	6·57	3, 2, 5, 4, 1
,, Dooha flat ...	6	13	26	21	22	9·60	3, 5, 4, 2, 1
,, Dukhi flat No. 2	5	2	18	30	33	9·63	5, 4, 3, 1, 2
,, Poloi flat No. 4	11	16	15	24	23	11·27	4, 5, 2, 3, 1

From Rukni, which stands well away from the hills, the analyses denote heavy flats and light *teelas* although in the latter the order —5, 4 for the clay and fine silt fractions is not observed.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Rukni Boudang flat ...	3	5	6	35	31	15·12	4, 5, 3, 2, 1
„ Pooni ...	48	23	7	11	7	3·61	1, 2, 4, 5, 3

Typical samples from Monierkhal are given below. Davenport *teela* is an exceptionally heavy type for a *teela*.

Soil mark.	Coarse sand	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Monierkhal	3	13	10	31	23	17·88	4, 5, 2, 3, 1
„	41	31	5	4	14	3·84	1, 2, 5, 3, 4
„	1	3	23	34	30	7·20	4, 5, 3, 2, 1
„ No. 6 *teela* ...	45	27	5	8	11	2·71	1, 2, 5, 4, 3
„ Davenport *teela* ...	25	28	8	15	18	4·87	2, 1, 5, 4, 3

The next gardens to be considered consist in those to the west of the district and the analyses include Kuttal, Ruttonpore, Rosekandy, Boro Jalinga and Noarbund. On all these gardens the usual soils representative of *teelas* and *thals* or flats are seen.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Kattal Merrowah No. 6 *teela*	40	23	10	13	8	4·09	1, 2, 4, 3, 5
„ Lag No. 3 *thal* ...	21	28	17	18	10	4·32	2, 1, 4, 3, 5
„ „ No. 2 *teela* ...	42	27	10	10	9	3·00	1, 2, 3, 4, 5
„ Bhoj *teela* No. 2 ...	11	39	15	14	15	4·17	2, 3, 5, 4, 1
„ B. P. *teela* ...	16	25	17	18	19	5·22	2, 5, 4, 3, 1
„ Singlo flat ...	7	22	29	23	15	4·53	3, 4, 2, 5, 1
„ B. P. No. 2 *thal* ...	39	30	11	10	6	2 53	1, 2, 3, 4, 5
„ No. 5 *teela* ...	39	28	9	12	8	3·30	1, 2, 4, 3, 5
„ A. P. No. 2 *thal* ...	51	32	5	6	2	1·55	1, 2, 4, 3, 5
„ „ No 7 *teela* ...	43	26	8	13	5	4·00	1, 2, 4, 3, 5
„ No. 1 *thal* M. ...	4	14	23	30	21	6·70	4, 3, 5, 2, 1
„ No. 1 *thal* Haltia ...	33	27	13	16	7	2·77	1, 2, 4, 3, 5
„ No. 1 *teela* Haltia ...	37	29	6	13	10	2·73	1, 2, 4, 5, 3
„ Sabitila, Haltia ...	48	24	9	10	5	2·47	1, 2, 4, 3, 5

The Ruttonpore samples are mostly of flats, all on the heavy side.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Ruttonpore No. 2 ...	3	15	17	27	28	7·09	5, 4, 3, 2, 1
,, No. 4 Chundowa	1	4	27	33	28	6·59	4, 5, 3, 2, 1
,, No. 6 Noonapani	3	24	24	21	21	6·32	3, 2, 4, 5, 1
,, No. 7 Chundooa-don ...	11	25	17	29	10	6 58	4, 2, 3, 1, 5

The following analyses are from the three divisions of Rosekandi.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Rosekandi No. 3 flat ...	2	33	21	22	15	5·56	2, 4, 3, 5, 1
,, No. 7 ,, ...	41	38	6	8	4	2·24	1, 2, 4, 3, 5
,, Shapore No. 5 flat	2	6	16	37	31	7·56	4, 5, 3, 2, 1
,, Mains No. 9 flat	19	36	11	18	11	10 80	2, 1, 4, 3, 5
,, Mains No 34 *teela*	59	18	5	8	7	2·74	1, 2, 4, 5, 3

Rosekandi no. 7 flat is extremely light for a flat, suggesting that the slope has been sufficient for the removal, by washing, of the coarse as well as the fine particles from the *teela*.

The two Boro Jalinga samples are apparently from a *teela* and a flat.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt	Clay.	Loss on ign.	Soil type.
Boro Jalinga A. ...	11	53	5	16	9	3·63	2, 4, 1, 5, 3
,, B ...	15	23	18	19	18	4·97	2, 4, 5, 3, 1
Noarbund bheel No. 1 ...	35	6	11	7	4	36·01	1, 3, 4, 2, 5
,, ,, No. 2 ...	22	20	21	10	6	18·12	1, 3, 2, 4, 5

Hailakandi.

The gardens in this district may be conveniently considered in the order as they occur down the eastern side of the valley and up the western side.

At Burnie Braes the following types occur.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Burnie Braes, Mohanpore Ext. B.	37	24	17	7	10	4·35	1, 2, 3, 5, 4
,, New Ext. flat ...	29	32	12	13	8	5·84	2, 1, 4, 3, 5
,, Zingari flat ...	47	11	10	11	10	10·49	1, 4, 2, 5, 3
,, Godown flat ...	2	2	16	44	25	10·81	4, 5, 3, 2, 1
,, No. 4 flat ...	31	45	7	8	5	3·82	2, 1, 4, 3, 5
,, No. 1 flat ...	16	14	18	24	14	13·39	4, 3, 1, 5, 2
,, Manipur ...	43	35	6	9	4	3·67	1, 2, 4, 3, 5
,, Natun flat ...	12	10	18	27	20	3·14	4, 5, 3, 1, 2

Bundookmara and Kalacherra are adjoining gardens and their analyses are shown below together.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign	Soil type.
Bundookmara, no blight ...	12	45	12	17	8	5·24	2, 4, 3, 1, 5
Kalacherra, blight ...	15	37	14	16	9	5 02	2, 4, 1, 3, 5
,, Go-bil ...	16	7	11	24	28	11·23	5, 4, 1, 3, 2
,, 10-acre flat ...	26	14	11	19	19	10·56	1, 5, 4, 2, 3
,, Rendi *thal* ...	40	28	7	9	11	4·03	1, 2, 5, 4, 3

At Jaffirband the soils are various types of flats. The first and last samples are *bheels*.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine Silt.	Clay	Loss on ign.	Soil type.
Jaffirband No 5 blk. 4 ..	1	5	10	36	29	17·93	4, 5, 3, 2, 1
,, "A" ...	11	38	13	17	13	7·65	2, 4, 5, 3, 1
,, "B" ...	47	16	7	12	13	4·09	1, 2, 5, 4, 3
,, No 5 flat ...	11	24	14	27	16	5 55	4, 2, 5, 3, 1
,, Kooki *thal* ...	16	34	15	15	15	4 22	2, 1, 4, 3, 5
,, Sect. 5 ...	6	9	17	26	27	14 71	5, 4, 3, 2, 1

From Bagh-o'-Bahar there are four samples three of fairly stiff flats, kept friable by the *bheel* nature of the soil, and one of a *teela* of the type common in Sylhet.

Soil mark.	Coarse sand	Fine sand.	Silt	Fine silt.	Clay.	Loss on ign.	Soil type.
Bagh-o'-bahar No. 5 flat ...	17	18	16	18	19	11 09	5, 4, 2, 1, 3
,, No. 12 flat	19	6	16	21	12	22·29	4, 1, 3, 5, 2
,, Ebrahim flat	9	16	16	17	22	17·56	5, 4, 3, 2, 1
,, No. 13 *teela*	57	15	8	6	9	4·20	1, 2, 5, 3, 4

From Lallamukh a great number of analyses are available showing the garden to consist largely of sandy flats. The flats which are inclined to be heavy are kept open and tractable by high organic matter percentages. Representative samples are shown.

Soil Mark.	Coarse sand.	Fine sand.	Silt.	Fine Silt.	Clay.	Loss on ign.	Soil type.
Lallamukh 88 flat ...	40	34	10	8	3	3 77	1, 2, 3, 4, 5
,, 90 flat ...	4	39	14	17	19	6 45	2, 5, 4, 3, 1
,, Sun No. 2 ...	8	15	15	22	29	9·75	5, 4, 2, 3, 1
,, Kuki flat ...	18	34	17	13	11	6· 3	2, 1, 3, 4, 5
,, N. Bichala F. ...	50	18	12	9	7	3·77	1, 2, 3, 4, 5
,, No. 2 flat ...	23	16	15	18	20	6·56	1, 5, 4, 2, 3
,, No. 4 ...	36	28	3	20	6	5·92	1, 2, 4, 5, 3

From Lallacherra the following are typical.

Soil mark.	Coarse sand	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Lallacherra No. 1 flat	16	9	25	16	15	15 65	3, 1, 4, 5, 2
,, No. 2 flat	37	23	16	5	12	4·56	1, 2, 3, 5, 4
,, Harinchra No. 1	18	26	14	20	12	8·95	2, 4, 1, 3, 5
,, Manoomia	14	37	16	15	12	5·08	2, 3, 4, 1, 5
,, *teela* ...	56	19	6	7	9	4·13	1, 2, 5, 4, 3

From Roopacherra—

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Roopacherra, Badlapar flat ...	7	26	14	30	16	6·53	4, 2, 5, 3, 1
,, Badlapar *teela*	48	23	4	13	7	3·83	1, 2, 4, 5, 3
,, Mona flat	2	6	18	36	27	9·40	4, 5, 3, 2, 1

The next four gardens, Dholai, Kukicherra, Manipur and Sultanicherra are situated in the narrow part of the Dhaleswari Valley. At Dholai the samples are all of heavy clay flats. At Kukicherra both stiff and light soils occur, although they appear

to be from flats. The heavy soils from the two gardens are very similar.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Dholai	1	7	20	39	26	4·54	4, 5, 3, 2, 1
,, ...	1	3	12	46	29	6 43	4, 5, 3, 2, 1
,, ...	1	3	10	39	31	12·69	4, 5, 3, 2, 1
Kukicherra ...	4	8	19	32	26	10 50	4 5, 3, 2, 1
,, ...	9	2	17	28	34	9·76	5, 4, 3, 2, 1
,, ...	2	8	11	25	42	10·74	5, 4, 3, 2, 1
,, ...	2	24	25	22	19	4·90	3, 2, 4, 5, 1
,, ..	28	26	11	16	11	5·54	1, 2, 4, 3, 5
,, ...	20	34	12	13	14	5·74	2 1, 5, 4, 3

The Manipur samples are of great interest for they were taken from the best sections, which carry some of the heaviest yielding tea in the world. The soils yielding best are rich clay flats.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Manipur	*nil.*	5	17	44	25	8·29	4, 5, 3, 2, 1
,, ...	25	30	13	18	9	4·35	2, 1, 4. 3, 5
,, ...	1	6	19	41	17	15·00	4, 3, 5, 2, 1
,, ...	*nil.*	6	15	43	27	8·02	4, 5, 3, 2, 1

The Sultanicherra samples are shown below. The first two are of a silt type, uncommon in Cachar.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Sultanicherra ...	4	15	42	19	14	6 43	3, 4, 2, 5, 1
,, ...	5	22	22	28	16	5·76	4, 3, 2, 5, 1
,, ...	5	4	24	40	19	6·42	4, 3, 5, 1, 2
,, ...	20	23	26	15	11	3 67	3, 2, 1, 4, 5

Proceeding now up to the western side of the Hailakandi Valley, analyses are available from Appin, Koyah, Singalla, Aenakhal, New Kunchunpore, Serispore and Chandypore.

From Appin the analyses are of an old *bheel*, showing a loss on ignition of only 3.61 per cent., of flats and a *teela*.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Appin No. 1 old *bheel*	45	31	5	9	4	3·61	1, 2, 4, 3, 5
,, No. 2 flat ...	5	6	30	29	37	7 86	5, 3, 4, 2, 1
,, No 3 flat ...	3	16	19	30	10	6·76	4, 3, 2, 5, 1
,, No 7 flat ...	14	8	10	28	20	13 20	4, 5, 1, 3, 2
,, No. 13 flat	10	56	13	9	5	3·67	2, 3, 1, 4, 5
,, New *teela* ...	38	22	6	9	14	5·90	1, 2, 5, 4, 3

From Koyah only two samples are available both from flats. The Singalla analyses include both *teelas* and flats.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Koyah No. 1 flat ...	26	18	11	16	13	13·94	1, 2, 4, 5, 3
,, Manipur flat ...	26	14	12	16	16	15·24	1, 4, 5, 2, 3
Singalla, Chota harina *teela* ..	11	14	21	18	29	6·65	5, 3, 4, 2, 1
,, No. 2 *teela*...	4	15	22	27	24	5·89	4, 5, 3, 2, 1
,, Lushai *teela*	58	17	8	5	7	3·04	1, 2, 3, 5, 4
,, Manik flat ...	3	5	28	33	23	5·42	4, 3, 5, 2, 1
,, Lakri flat ...	2	26	26	21	19	5·48	3, 2, 4, 5, 1
,, Rupa flat ...	2	10	30	27	23	7 12	3, 4, 5, 2, 1
,, Lall flat ...	1	3	23	34	30	7·87	4, 5, 3, 2, 1
,, Bara Harina	5	13	22	25	26	8·55	5, 4, 3, 2, 1
,, Kachari flat	4	41	23	15	12	4·76	2, 3, 4, 5, 1

The stiff *teela* soils at Singalla are of interest, resembling as they do, the plateau soils north of the Surma.

From Aenakhal a great number of analyses are available. Typical soils are shown below.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Aenakhal, Golf *teela* ..	47	23	12	5	10	4·02	1, 2, 3, 5, 4
,, Jaynugger *teela* ...	42	22	14	6	12	3·88	1, 2, 3, 5, 4
,, Moorti *teela*	63	15	7	5	7	2·92	1, 2, 3, 5, 4
,, No. 2 *bheel*...	26	6	14	16	20	16·64	1, 5, 4, 3, 2
,, *Seedam busti*	5	27	37	13	12	4·11	3, 2, 4, 5, 1
Monacherra bungalow *teela* ...	35	36	10	4	12	2·64	2, 1, 5, 3, 4
,, Labu *teela*	9	16	25	17	25	6·94	3, 5, 4, 2, 1

The last analysis suggests a plateau soil rather than a *teela*.

The New Kunchunpore samples appear to be of flats. Those from Serispore are interesting in that some of the *teela* soils resemble the plateau soils of the Happy Valley. All the Chandypore samples are of flats.

Soil mark.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Soil type.
Kunchunpore No. 1 ...	1	3	11	33	42	8·01	5, 4, 3, 2, 1
,, No. 2 ...	2	10	30	31	20	5·45	4, 3, 5, 2, 1
,, No. 3 ...	1	9	18	35	29	6 40	4, 5, 3, 2, 1
,, No. 4 ...	5	8	14	35	30	6 60	4, 5, 3, 2, 1
Serispore Chotabar *teela*	12	14	19	11	33	10 65	5, 3, 2, 1, 4
,, Koyalhall ,,	18	34	17	11	13	5·54	2, 1, 3, 5, 4
,, No. 1 *teela*...	1	10	19	39	24	6·38	4, 5, 3, 2, 1
,, No. 2 ,, ...	35	30	11	12	8	3 87	1, 2, 4, 3, 5
,, No. 3 ,, ...	2	17	16	26	28	8·43	5, 4, 2, 3, 1
,, No. 4 ,, ..	32	21	7	13	16	6 14	1, 2, 5, 4, 3
Chandypore No. 7 flat	5	43	23	12	11	4·60	2, 3, 4, 5, 1
,, No. 8 ,,	7	36	25	16	11	5·11	2, 3, 4, 5, 1
,, No. 3 ,,	5	16	29	26	16	5·68	3, 4, 5, 2, 1

SOIL WASH.

BY

P. H. CARPENTER.

The prevention of soil loss by erosion is one of the most difficult problems confronting those who practise agriculture on sloping land. To the tea industry the problem is of great importance, and in such districts as Darjeeling and South India the prevention of soil wash may become the chief problem of the estate. The prevention of soil erosion must, however, receive attention in almost all the tea districts, for, with the exception of the Brahmaputra Valley, nearly all the other areas consist largely of sloping land. Even in the Brahmaputra Valley there are many slopes such as *hullah* sides, etc., that are obviously suffering from soil erosion.

In the case of annual crops the loss of soil by erosion might not seem to be of so great importance, were it not for the fact that it is the top layer of the soil that is lost, the only part of the soil well fitted for plant growth. If the surface layer of the soil is lost then the soil becomes, to a great extent, merely a collection of inert mineral particles. In the case of perennial crops, like tea, not only is the loss of the fertile top soil of as much importance as in the case of annual crops, but the exposure of roots by soil erosion is an additional source of loss of cropping capacity of the bushes.

The factors of most importance influencing the loss of soil from slopes by erosion are—

(*i*) Rainfall,
(*ii*) the type of soil,
(*iii*) the slope of the land.

Whilst the total annual rainfall must, to some extent, determine whether any erosion is likely to occur, yet, of more importance is the distribution of the rainfall. If the rain is evenly distributed throughout the year, with no periods of excessive precipitation, then a high annual rainfall may cause less

erosion than a much lower rainfall unevenly distributed. Consider the rainfall in Darjeeling and Buitenzorg, Java.

	India Darjeeling. ins.	Java Buitenzorg. ins.
January ...	0.76	17.6
February ...	1.08	15.9
March ...	2.01	16.6
April ...	4.08	16.2
May ...	7.83	14.9
June ...	24.19	11.1
July ...	13.74	10.2
August ...	25.98	8.2
September ...	18.34	13.5
October ...	5.35	16.7
November ...	0.24	15.6
December ...	0.20	14.6
Total ...	121.80	171.7

Buitenzorg with a higher rainfall than Darjeeling by 50 inches per annum is less likely to suffer loss of soil by erosion than Darjeeling, where the rainfall is concentrated so that 100 inches are registered in about 120 days.

The loss of soil by erosion is caused by rain that cannot soak into the soil, but is forced to run off over the surface. Consequently the nature of the soil plays a large part in determining the amount of erosion that will take place from a definite rainfall.

A coarse-grained, sandy soil into which water can easily and quickly penetrate, will be less subject to erosion than a fine grained soil through which water can only move slowly, forcing a much greater percentage of the rainfall to run off the surface. In addition, owing to the smallness and lightness of the soil particles in a clay soil, their removal will be easier than in the case of a coarse grained soil.

The depth of the easily permeable layer of the soil is also of importance, for the greater this depth the greater will be the amount of water that can be absorbed before it becomes saturated, and consequently the longer will be delayed the time when run off of water must take place. In the tea districts, however, during the Monsoon period the soil remains so near the saturation point that run off very quickly occurs no matter what the type of soil may be, and the main preventive against loss then becomes the inertia of the soil particles, or the presence of mechanical obstructions.

The slope of the land must be considered as the greatest factor governing the loss of soil by wash. On a steep slope, the water as it runs off a smooth surface of soil (and under the battering effect of direct rainfall a soil surface quickly becomes smooth) attains such a velocity that it is capable of carrying along with it soil particles. The greater the velocity of the water the larger the soil particles that can be moved.

The following table gives the velocity of water in inches per second required to move particles of varying sizes.

Rate of water flow.		Size of particles moved.
3 ins. per sec.	or 0.170 miles per hour ...	Clay.
6 ,, ,,	0.340 ,, ,, ,, ...	Fine sand.
8 ,, ,,	0.455 ,, ,, ,, ...	Sand as coarse as linseed.
12 ,, ,,	0.682 ,, ,, ,, ...	Fine gravel.
24 ,, ,,	1.364 ,, ,, ,, ...	Pebbles 1 inch in diameter.
36 ,, ,,	2.045 ,, ,, ,, ...	Small stones.

It is difficult to obtain any accurate figures regarding the rate at which water runs off a soil slope, but some approximate idea of this can probably be obtained by the use of the formula relating to the flow of water in drains, *viz.*

$$V = C\sqrt{R \times S}$$

where V = the velocity of the water in the drain in feet per second.

R = Cross sectional area of drain in square feet divided by the wetted perimeter of drain in lineal feet.

S = The slope of the land.

C = A coefficient obtained from Bazin's formula for water flowing in earthen channels.

$$= \frac{1}{\sqrt{\cdot 00008534\left(R + \frac{4 \cdot 1}{R}\right)}}$$

If the width of the water flow is very much greater than the depth of the water, *e.g.*, if we consider not a drain, but water flowing freely over the surface, then, the maximum velocity of the water is directly proportional to the depth of the water and the square root of the slope.

The following table gives the maximum velocity, in feet per second, for varying depths of water and of slope.

Velocity of water in feet per second.

Slope.	Depth of water.			
	1 inch.	¾ inch.	½ inch.	¼ inch.
1 in 100	0·44	0·33	0·22	0·11
1 „ 80	0·50	0·37	0·25	0·12
1 „ 60	0·56	0·43	0·28	0·14
1 „ 40	0·70	0·52	0·35	0·17
1 „ 20	1·00	0·74	0·50	0·25
1 „ 10	1·4	1·05	0·70	0·35
1 „ 6	1·80	1·35	0·90	0·45
1 „ 5	1·97	1·48	0·98	0·49
1 „ 4	2·20	1·66	1·10	0·55
1 „ 3	2·55	1·91	1·27	0·63
1 „ 2	3·12	2·34	1·56	0·78

Water flowing at a depth of one inch over a slope of 1 in 100 will attain a maximum velocity of .44 feet or 5¼ inches per second. This will be a sufficient velocity to remove fine clay, but not sufficient to remove fine sand or any larger sized soil particles.

If the water were flowing with a depth of only half an inch then no particles of soil would be moved. Reference to the above table shows that the slope would have to be increased from 1 in 100 to 1 in 80 in order to move clay particles with water flowing at a depth of half an inch.

If the water had a depth of only ¼ inch then the fine clay particles would not be moved until the slope became 1 in 20.

For fine sand to be moved with a depth of water of one inch the slope would need to be 1 in 80. With half an inch of water the slope would have to be increased to 1 in 20.

A heavy fall of rain may produce a depth of water that may easily attain a velocity sufficient to carry away sand particles, and, if the slope is long, the accumulated water from the upper parts of the slope may reach a depth on the lower part sufficient to cause most serious erosion.

The amount of water that will percolate through the soil varies with the class of soil. For instance, fine sand (passing through 100-mesh sieve) will allow 40 inches of water to pass in 24 hours through a column 14 inches in depth, with a head of water maintained at two inches.

On the other hand, a clay loam, under similar conditions, will allow only 1.6 inches of water to pass through. This seems to indicate that a sandy soil, containing no fine particles, would allow water to pass through at a rate sufficient to deal with a rainfall of one inch per hour, if not extended over several hours.

When the spaces between the soil particles become filled with water, the soil is then saturated and unless the rate of percolation is rapid, practically all the rain falling after that condition is reached must run off. It is therefore of interest to know the amount of water that will run off an area from a definite rainfall.

The following table shows the cubic feet of water collecting on one acre of land at various hourly rates of rainfall.

Rainfall inches per hour.

Rainfall per hour.	$\frac{1}{16}$ inch.	$\frac{1}{8}$ inch.	$\frac{1}{4}$ inch.	$\frac{1}{2}$ inch.	1 inch.	2 inches.
Cubic feet water falling on an acre per hour ...	363	454	901	1,815	3,630	7 620

For a rainfall of one inch per hour the drain discharge for one acre, assuming that all the water ran off, would need a capacity of 3,630 cubic feet per hour, equal to 22,690 gallons. Taking a safe velocity of water in an ordinary earth drain to be 2.5 ft. per second, then a drain with a 6-inch bottom sloping at 1 in 16 will fill to a depth of 9½ inches in carrying away the volume of water under consideration *viz.*, 22,960 gallons.

Whilst the figures above are but approximations, yet they are of considerable interest in indicating how very necessary it is to take precautions against soil wash on even very slight slopes. They also indicate how very necessary it is to control the run off over a slope before it has attained more than a slight depth, and the greater the slope the greater the necessity for control. Detailed attention must also be paid to the discharge capacity of the drains and their angle of slope.

The difficulties to be overcome to prevent erosion on tea gardens are very serious and unfortunately there is little experimental data dealing with the subject. Considerations, therefore, of the means that may be adopted to minimise the trouble are largely based on theoretical data and general experience.

The prime factor of the problem appears to be how to reduce the velocity of the flow of water over a slope to such an extent that erosion will not take place. This can be done in several ways. The first and probably the most efficient method is by terracing, arranging that the slope of the terrace in any direction is not great enough to allow of soil movement. The run

off water from each terrace must be taken away under control in its own drainage channels, and not allowed to pass from one terrace to the next lower one. On the more gentle slopes, terraces can be formed by building contour *bunds,* but on steep slopes the terraces must be cut out.

A slope of 1 in 5 would require a *bund* 9 inches high every 5 feet in order to form a terrace having a slope of 1 in 20 on which water ¼ inch deep would attain a velocity that it could just move clay and no other particles. Such *bunding* would be impracticable so that, for this slope, cut terraces are required.

A slope of 1 in 10 would require a *bund* 6 inches high every 10 feet in order to form a terrace with slope of 1 in 20.

It is only necessary to go into forest land on hillsides to realise that some conditions are present that very materially reduce soil erosion. Perhaps three of these factors may with advantage be mentioned.

(1) The first is the overhead cover provided by the growing trees. This prevents, to a very great extent, the battering effect of the rain falling directly on to the soil and reduces the velocity of the rain drops before they reach the ground.

(2) The second is the random distribution of jungle plants. The absence of any straight line effect up and down the hill does much to prevent the formation of water gullies.

Unfortunately on many tea gardens the bushes are planted in straight lines up and down the slope, a form of planting tending seriously to increase erosion. In such areas it is often noted that water channels form in the lines between the bushes, and if very careful precautions are not taken to prevent soil loss, in a very few years the bushes are gradually left on pinnacles or very narrow individual terraces.

The type of planting providing the greatest amount of immunity from wash is regular contour planting. Because this method of planting is not quite so simple as straight up and

down planting it was not generally adopted in the earlier days. With regard to the supposed greater working inconvenience on contoured areas, it is true that it does make the garden operations of plucking and pruning less easy, but on the other hand it does reduce the tendency to cultivate up and down the hill, another source of soil loss to the upper slopes. Contour planting does not interfere with cultivation but rather aids it, in that it induces it to be done in a better manner.

(3) Another factor reducing soil wash in the jungle is the accumulation of organic matter in the form of dead branches, twigs and leaves. These provide a mulch over the soil and very largely act as a protective layer, which no doubt itself suffers loss, but is renewed year by year.

It would seem possible to utilise this method in tea gardens by leaving the annual leaf fall from the bushes and also the prunings and jungle growth that have been sickled, on the surface, instead of turning it under the soil. Undoubtedly such a procedure would very materially reduce soil loss and such methods have at times been employed, but the continuance of such a practice on any one particular area requires caution, for the collection of rotting organic matter tends to accumulate against the stems of the tea bushes and disease can readily spread from the rotting matter to the tea bush itself. This has happened many times in tea, and outbreaks of disease, *e.g., Rosellinia arcuata*, have occurred which may easily assume serious proportions. Another real danger is that the encouragement of such a mulch on the surface of the soil encourages the propagation of insect pests.

Although a mulch of rotting vegetable matter cannot be safely employed to stop soil wash, a growing crop may be used with the same object. Weeds and small plants growing as a cover on the soil do greatly help to prevent wash, partly because the roots tend to bind the soil but mainly by reason of the check upon the rate of flow of water over the soil surface. In this manner it is possible to prevent the water from reaching a velocity that it would attain in flowing over a clean land slope.

Unfortunately the growing of jungle on a tea area reduces the crop but it is noticeable that certain classes of jungle do this far less than others. Shallow rooting plants have a less harmful effect than have some of the deeper rooting grasses.

If, therefore, the use of a cover crop is to be employed for preventing soil wash, a system of selective weeding must be adopted. So far but very little has been done in North-East India in this direction although other tea districts have given the matter rather more attention. Selective weeding, however, has its difficulties and perhaps a simpler way of dealing with the matter is to grow some shallow rooting crop. This has been tried and a number of plants appears to have given successful results, *e.g.*, *Indigofera endecaphylla, Vigna oligosperma, Desmodium triflorum, Crotalaria incana,* Mixed *crotalaria, Ipomaea.*

The following figures afford comparative data. They are taken from the records of the Peradeniya Experimental Station, Ceylon, showing the loss of soil by erosion on unprotected soil and also on soils on which various plants are being grown.

	Loss by erosion in lbs.
Soil untreated ...	... 814
Crotalaria incana ...	... 309
Mixed *crotalaria* ...	... 176
Ipomaea ...	... 133
Desmodium triflorum	... 30

Ashplant in his experiments on an area growing rubber on a slope of 1 in 5 gives the following comparative data :—

	Loss of soil by wash.	
	tons.	cwts.
Plot 3, leguminous cover crop ...	0	14.4
,, 4, hand weeded ...	... 5	17.3
,, 5, weeded by *mamooty* (light cultivation) ...	... 7	17.0

Another pair of plots shows the effect of allowing weeds to grow.

Loss of soil by wash.

	tons.	cwts.
Plot I, no deep cultivation. Light cultivation by *mamooty* (hoe) ...	22	4.6
Plot II, no deep cultivation. Circles around trees only clean weeded	0	1.6

The reduction of the velocity of water over a slope can also be accomplished in some measure by growing certain plants in the form of hedges along the contour. Thus—

Loss by erosion in lbs.

Crotalaria in lines across slopes ...	50
Untreated soil	814

The battering of the rain on the soil surface of a slope quickly tends to produce a smooth surface over which the water can attain maximum velocity. If the soil surface can be kept in a rough uneven state then the velocity of the water will be greatly retarded.

Soil lost by wash.

Treatment.	tons.	cwts.
Plot 1, no deep cultivation ...	13	13
,, 5, deep cultivation	7	17

Both plots were weeded by *mamooties* (light cultivation).

Plot 4, hand weeded	5	17
,, 5, weeded by *mamooty* (light cultivation)	7	17

The following data obtained by Ashplant from an experiment on a rubber planted area in South India are of value.

	tons.	cwts.
Plot IV, hand weeded, deeply dug before experiment	5	17.3
Plot V, hoed *mamooty*, but deeply cultivated shortly before experiment	7	17.0

	tons.	cwts.
Plot I, hoed *mamooty* but no cultivation by digging for eight months previous to experiment ...	22	4.6
Plot VI, Contour pits and bunds with clean weeding	1	17.6

The slope of the land on which the above experiments are being conducted is 1 in 5. The area is under rubber trees.

Cultivation, providing a loose layer of soil, allows the rainfall to soak quickly into the soil and thus prevents water remaining on the surface. So long as the soil can absorb the rain that is falling for so long will there be no loss by wash. It is not until the soil can no longer absorb the rainfall that run-off over the surface takes place. This seems clearly to indicate that the deeper a soil is loosened the less will be the likelihood of run off. That is to say that deep cultivation will prevent loss by wash more effectively than shallow cultivation. This is borne out by the data given above.

It is however necessary to remember that a soil layer saturated with water resting on a more compact layer has a tendency to slip as a whole, and consequently on well cultivated areas the provision of contour drains that will carry the water away from the area are necessary. Contour drains must also be so devised that water does not remain in them but that it is quickly discharged so that the soil in the neighbourhood of the drain is not kept in a saturated condition.

On cultivated land the finer particles of soil may often be washed away but the coarser particles such as sand may be left behind. The layer of sand on the soil surface then acts as a mulch of coarser particles and prevents the erosion of the soil below the layer. When such a layer is formed the soil should not be dug to a depth greater than the depth of the sandy layer for every time deeper digging is done a fresh layer of soil containing finer particles is brought to the

surface and the finer particles washed away. A sandy layer of soil having a depth of perhaps 7 to 8 inches can be obtained and this prevents soil loss, but great care needs to be taken to remove the water that percolates through the sandy layer as quickly as possible so as to prevent its becoming so saturated with water as to allow a slip to take place.

When devising contour drains to remove the water it is obvious that they must not have so great a slope as to allow the water to attain such a velocity as to erode the drain, nor to carry away in suspension any of the larger sized soil particles. It is often difficult so to construct drains that fulfil all the necessary conditions. In such cases where the drain slope is unavoidably too great much can be done to reduce the velocity of the water by filling the drains with faggots of prunings or similar material.

Protection by shading with trees or by the foliage of the tea bushes themselves, also helps to reduce soil wash. The effect of shade is very clearly to be noticed on some tea areas in the hilly districts of North-East India and under areas on which the tea bushes are fully grown.

The following data obtained from Ceylon illustrate—

	Loss by erosion in lbs.
Soil unshaded ...	... 814
Dadap (*Erythrina indica*) ...	... 330
Albizzia	... 168

ON THE INCIDENCE OF INSECT PESTS AND FUNGUS DISEASES ON TEA AT TOCKLAI.

BY

E. A. ANDREWS.

At the end of 1917 a small area of tea at Tocklai, planted in the cold weather of 1915-16, was set aside for the purpose of making observations on the incidence of insect pests, and on the possible effect of different treatments in encouraging or discouraging attack by different pests.

The different treatments initiated were as follows :—

Manuring—	Plot A	to receive Nitrogen and Potash.
	,, B	,, Nitrogen only.
	,, C	,, Nitrogen & Phosphoric Acid.
	,, D	,, Potash only.
	,, E	,, Potash & Phosphoric Acid.
	,, F	,, Phosphoric Acid only.
	,, G	,, No manure.
	,, H	,, Nitrogen, Potash & Phosphoric Acid.
Pruning—	,, I	to be cleaned out when pruning.
	,, J	not to be cleaned out.
	,, K	to be pruned badly so as to leave snags.
	,, L	to be pruned carefully to leave no snags.
	,, M	not to be collar pruned.
	,, N	to be collar pruned.
	,, O	to be pruned on one-year wood.
	,, P	to be pruned on two-year wood.
Miscellaneous—	,, Q	to be plucked hard.
	,, R	to be plucked lightly.
	,, S	to be kept clean and free from jungle.
	,, T	to be allowed to be smothered in jungle.

Plot U to be treated at intervals with lime-sulphur.
,, V to be treated at intervals with Bordeaux mixture.
,, W to receive no such treatment.

At convenient intervals during each subsequent year, the bushes have been subjected to careful observation and the insects (and fungi) occurring on each bush recorded. In all, 49 observations have now been made, and as certain small differences in behaviour are beginning to be noticeable it has been decided to commence the issue of a series of progress reports on the behaviour of the different pests.

It is interesting, first, to note the relative frequency with which the different pests were found on the area. This is shown in the following list, the possible number of occurrences being 6,762.

Insects and Mites—Red Spider	Occurred	5382	times.
Tea Aphis	,,	1850	,,
Leaf Rollers	,,	448	,,
Nettle Grubs	,,	124	,,
Tea Seed Bug	,,	98	,,
Gelatine Grubs	,,	66	,,
Termites	,,	36	,,
Looper Caterpillar	,,	28	,,
Sandwich ,,	,,	14	,,
Scale Insects	,,	12	,,
Lymantriid Caterpillars	,,	8	,,
Red Borer	,,	4	,,
Bark Eating Borers	,,	2	,,
Faggot Worms	,,	2	,,
Tea Leaf Mining Fly	,,	2	,,
Red Slug	,,	1	,,
Conical Psychid	,,	1	,,

Fungi—	Brown Blight	Occurred 6624	times
	Red rust	,, 5224	,,
	Cercospora	,, 402	,,
	Copper blight	,, 52	,,
	Stem diseases	,, 12	,,
	Grey blight	,, 6	,,
	Blister blight	,, 2	,,

The relative importance, on these plots, of the various insect pests and fungus blights, is very well shown.

It is, moreover, obvious that in the case of most of the pests and blights the number of occurrences has been so small that the accidents which affect the distribution of all pests and blights cannot be ignored, and no reliable conclusions on the effect of the different treatments on their distribution can be drawn.

In the case of red spider, tea aphis, and leaf rollers among the insects, and of brown blight, red rust, and Cercospora among the fungi, however, there is a sufficient number of observations to make a study of the records worth while. Taking the number of times a pest or disease has been recorded from the bushes in a plot, and dividing by the number of bushes in the plot, one obtains a figure for the average number of times each bush in a plot was found to be infected.

In this way the following table is obtained :—

Plot.	Treatment.	Brown blight.	Red rust.	Cercospora.	Red spider.	Tea Aphis.	Leaf Rollers.
A	Nitrogen and Potash ...	36·0	23.5	1·5	23·2	9·7	1·8
B	Nitrogen only ...	40·5	26·5	2·3	24·8	9·5	1·7
C	Nitrogen and Phosphoric Acid	38·3	25·2	1·5	25·7	10·3	1·8
D	Potash only	35·0	28·0	1·6	25·0	10·5	1·3
E	Potash and Phosphoric Acid	32·5	23·0	1·2	26·0	10·3	0·8
F	Phosphoric Acid ...	37·0	26·7	2·0	28·5	9·2	3·0
G	Nil	38·0	26·8	2·8	26·8	9·0	3·5
H	Nitrogen, Potash and Phosphoric Acid ...	33·6	30·6	1·5	24·5	11·0	2·6

Plot.	Treatment.	Brown blight.	Red rust.	Cerco-spora.	Red spider.	Tea Aphis.	Leaf Rollers.
I	Not cleaned out in pruning	30·5	40·2	1·3	31·5	8·0	1·3
J	Cleaned out ...	25·7	20·0	1·7	24·0	11·2	2·0
K	Snag pruned... ...	28·0	35·3	1·3	31·7	10·0	1·7
L	Clean ,, ...	25·7	18·3	1·5	29·0	10·2	1·2
M	Not collared	28·2	20·8	1·5	27·5	7·7	2·5
N	Collared	25·5	18·5	1·5	22·6	11·2	2·5
O	Pruned on 2-year wood ...	27·5	25·3	1 0	28·0	11·5	2·0
P	Pruned on 1-year wood ...	27·6	20·0	1·2	23·6	10·3	2·5
Q	Hard plucked ...	36·7	28·3	3·3	32·2	9·5	9·5
R	Lightly ,, ...	38·7	28·2	3 5	28·6	9·0	9·0
S	Free from jungle ..	38·0	30·3	3·0	30·0	8·0	8·0
T	Overrun with jungle ...	35·9	24·5	2·8	20·3	4·7	4·7
U	Lime-sulphur ...	38·0	28·0	3·0	30·5	8·0	8·0
V	Bordeaux mixture ...	34·3	27·0	3·7	26·0	7·7	7·7
W	Untreated	36·6	28·8	1·5	29·2	6·3	6·3

With the help of the above table the incidence of a pest or blight can be compared with the treatment the different plots received.

The results on most of the manured plots are irregular, but it will be observed that in the case of all three fungi the plot which has consistently received potash and phosphoric acid was observed to be infected on the fewest number of occasions. In view of the number of observations this can hardly be coincidence, and moreover the observation is in line with the results obtained at Borbhetta, where it has been found that, whereas potash applied alone may have little effect, its effect becomes very marked when phosphoric acid is applied with it. With regard to insects and mites the manuring has had no influence which can be traced.

In the plots devoted to pruning treatments the results are more strongly marked. It will be observed that in the case of brown blight, red rust and red spider all processes which tend to bring about the retention of poor and old wood in the bushes for a shorter or longer period cause an increase in the prevalence of the fungus. Thus the plots carefully cleaned out and carefully pruned show less infection than those in which cleaning out is omitted and pruning done carelessly, so that the bushes are full of unproductive and non-vegetative shoots. In the plot

which was not collar-pruned there is a tendency for there to be more shoots of this kind than in the plot in which the bushes have been built up on clean straight stems from the ground, and there is a consequent increased liability to presence of the diseases. In the tea pruned only every other year, too, unproductive shoots remain on the bushes long enough to be affected. Cercospora, and tea aphis, on the other hand, appear to prefer light and air in the bushes, and sound flushing shoots, while the distribution of leaf rollers shows no relation to the treatment.

Hard plucking seems to have had no effect, so far, in increasing liability to attack by fungi, in fact the figures tend to show the opposite result. Red spider has shown up a little more on the hard-plucked bushes, while the leaf-rollers, as is only to be expected, show up more on the lightly plucked bushes.

A noticeable feature is that the plot left smothered in jungle the whole time has been distinctly less attacked by both insects and fungi than the plot, alongside, in which jungle was always kept down.

Spraying has scarcely affected the incidence of pests and blights, though the Bordeaux mixture would appear to be better as a preventive than Lime-sulphur.

It should be noted that all the above remarks refer to the incidence of the various pests and blights, and not to the amount of damage done. This is not being measured in this experiment.

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1926	do.	Available.	do.	do.	0 12 0
1927	do.	do.	do.	do.	0 12 0
1928	do.	do.	...	...	0 12 0

†Bound volume for 1917 is available.

Copies of the above, except those which are out of stock, may be had from the Secretary, Indian Tea Association, Calcutta (Post box 280).

Corrected up to 31st July 1928.